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Engineering Equipment of a Modern Printery

ISOLATED PLANT OF THE HENNEBERRY CO., CHICAGO, WHICH SHOWS PROFIT DESPITE INCREASING COST OF OPERATION

CHICAGO IS THE POINT of distribution of thousands of publications, and therefore naturally has within its bounds nearly as many printing and binding establishments, the products of which reach the four corners of the earth, and in quality rank well among the first in the printers' art. One of the largest of these is the new plant of The Henneberry Co., located in the southwestern part of the city, at 455 W. 22nd St., and consisting of a reinforced steel-concrete structure having an overall length of approximately 290 ft., a width of 85 ft., and 4 stories in height.

The equipment installed is the most modern built for printing, binding and the manufacture of catalogs in which this company specializes. And as the demands of the business require the working of day and night shifts, frequently every day of the week, uninterrupted operation of machines and that at the highest degree of economy necessitated the installation of a private steam and electric power generating plant. This has been placed in the basement on the 22nd St. side of the

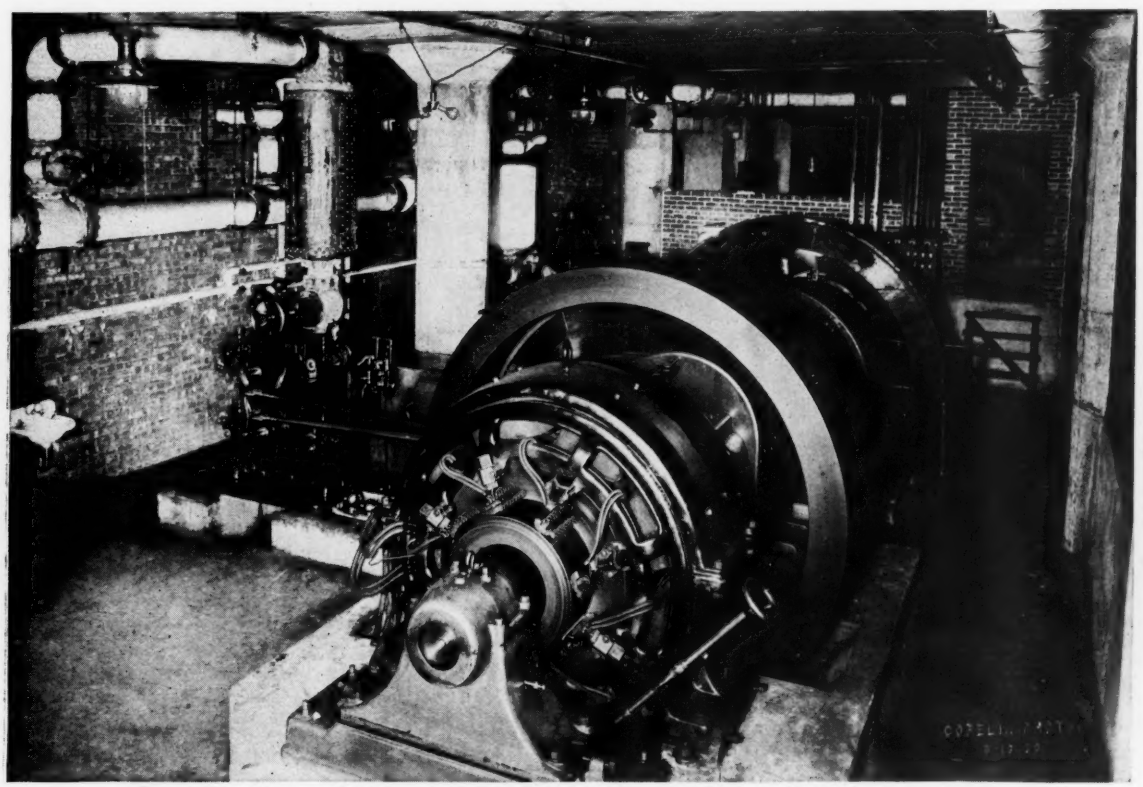


FIG. 1. GENERAL VIEW OF ENGINE ROOM OF THE HENNEBERRY BUILDING

building and consists essentially, as shown in Fig. 2, of a pump room, a boiler room and the engine room.

Electric Service Requirements

Each machine, of which there are 122 in the establishment, is equipped with its individual driving motor, the smallest being a ¼-hp. unit, while the largest, that used in connection with a giant Hoe press, is rated at 50 hp.; the total connected load is somewhat in excess of 500 hp.

Three-wire electric distribution with conductors carried in iron conduit imbedded in concrete is employed. The motors are supplied with current at 220 v., while the lighting units which are connected across either of the outside leads and the neutral are supplied with current at 110 v. Any unbalancing of load tending to exist is readily corrected by means of a balancer set in the engine room, made up of 2 directly connected 10-kw., 115-v. Sprague direct-current generators.

Steam-Generating Equipment

Steam which is used for the operation of the electric generating units and pumps and to heat the water for domestic and boiler feed purposes, the glue pots, the plates of 7 embossing machines and the bindery machinery is generated by 2 Springfield marine-type boilers. Each of these, rated at 250 hp., is equipped with a McMillan dutch oven furnace and although the pressure normally carried ranges from 125 to 150 lb. gage, they can, if necessary, withstand a working pressure of 250 lb. per sq. in.

Coal is delivered to the plant in cars run on a siding and by means of chutes is transferred to a storage bin having a capacity of 250 tons, a sufficient supply under normal conditions for at least 30 days. It is fed to the furnaces by hand.

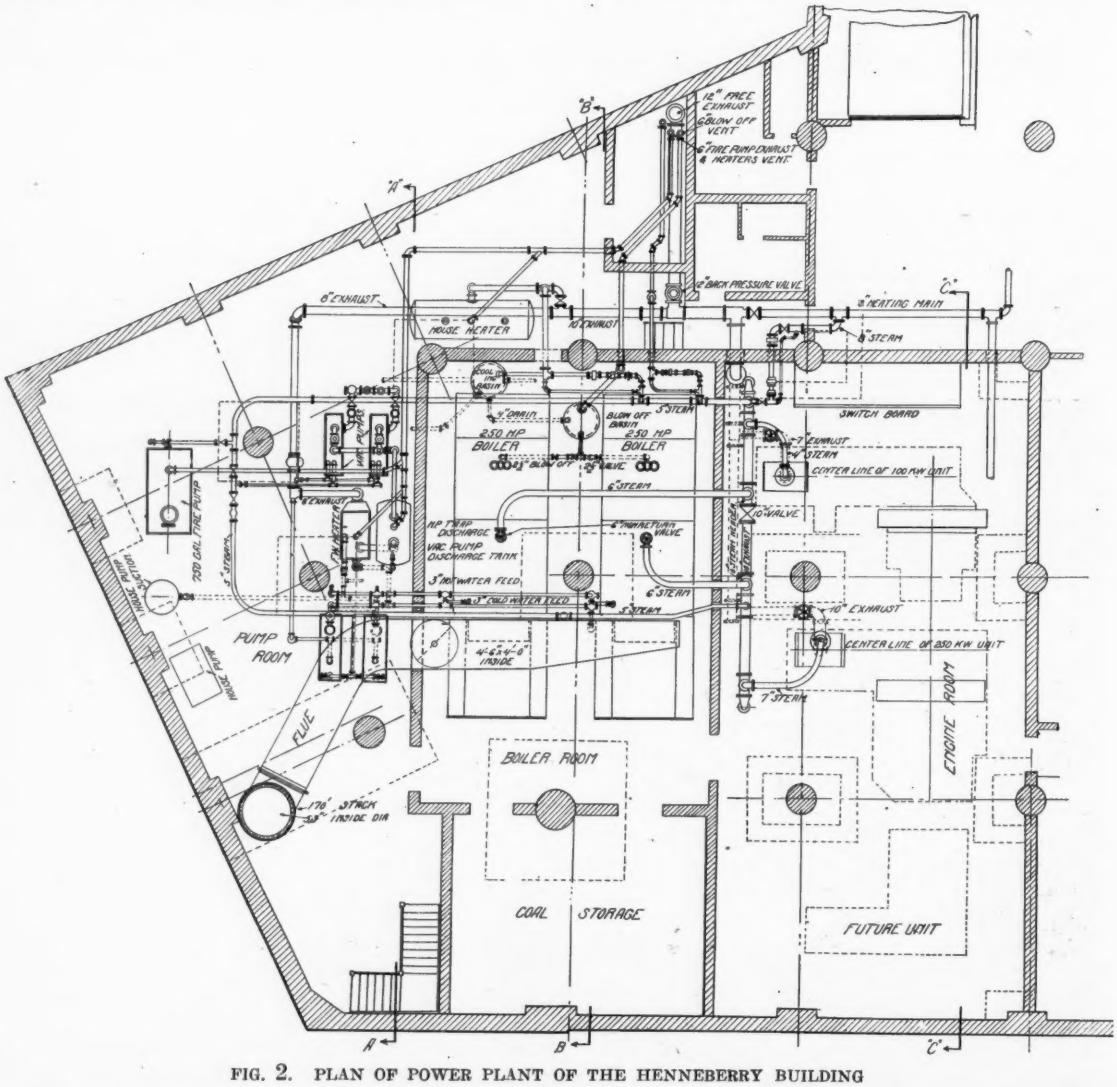


FIG. 2. PLAN OF POWER PLANT OF THE HENNEBERRY BUILDING

The uptakes of the boilers connect to an asbestos-lined steel stack having an inside diameter of 53 in. and a height of 170 ft., by means of a sheet-metal breeching having dimensions at boiler No. 1 of 4 ft. 6 in. by 4 ft. and at boiler No. 2 of 2 ft. 6 in. by 4 ft., thus allowing 0.0306 sq. ft. of stack section and 0.036 sq. ft. of breeching section per rated boiler horsepower. The breeching is made up of 3/16-in. sheet iron reinforced by angle irons, and is covered with asbestos.

Water may be fed to the boilers by either one of two 3-in. lines. The 2½-in. blowoff lines, each of which is fitted with one Lunkenheimer and one Crosby valve, terminate in a common connection, discharging into a 30-in. by 3-ft. blowoff tank placed below the floor level. Steam entering this tank is discharged to the atmosphere through a 6-in. vent and, as the blowoff tank fills, its contents flow into a cooling tank of the same size, thence into a receiving basin having a diameter of 4 ft. and a depth of 7 ft. From here they are pumped into the sewerage system by an automatic float-operated vertical Yeomans bilge pump, driven by a 1-hp. electric motor, and having a capacity of approximately 150 gal. per min.

One of the interesting features of this installation is the method of control and scheme of connections employed in conjunction with the boiler-feed and house service pumping equipment. This consists of three 7 and 4½ by 8-in. Canton-Hughes outside-packed plunger pumps, arranged as shown in Figs. 2, 3 and 4. Suction and discharge lines are so interconnected and equipped with valves as to allow any one or more of these units to be used for boiler feed purposes or for house service either with cold water taken directly from the city mains or hot water at a temperature of 212 deg. F. from a 500-hp., open-type IXL feed-water heater and purifier.

As may be seen by referring to Fig. 4, the steam supply lines of each of these pumps are equipped with two Boylston pump governors, one of which is adjusted for 155 lb. working pressure for use when the pump is operating as a boiler feed, and the other adjusted for 45 lb. working pressure for use when the pump is supplying the house service. These governors may be cut in and out of service by means of valves provided for the purpose.

The remaining equipment of the pump room consists of one 16 and 9 by 12-in. Underwriters fire pump

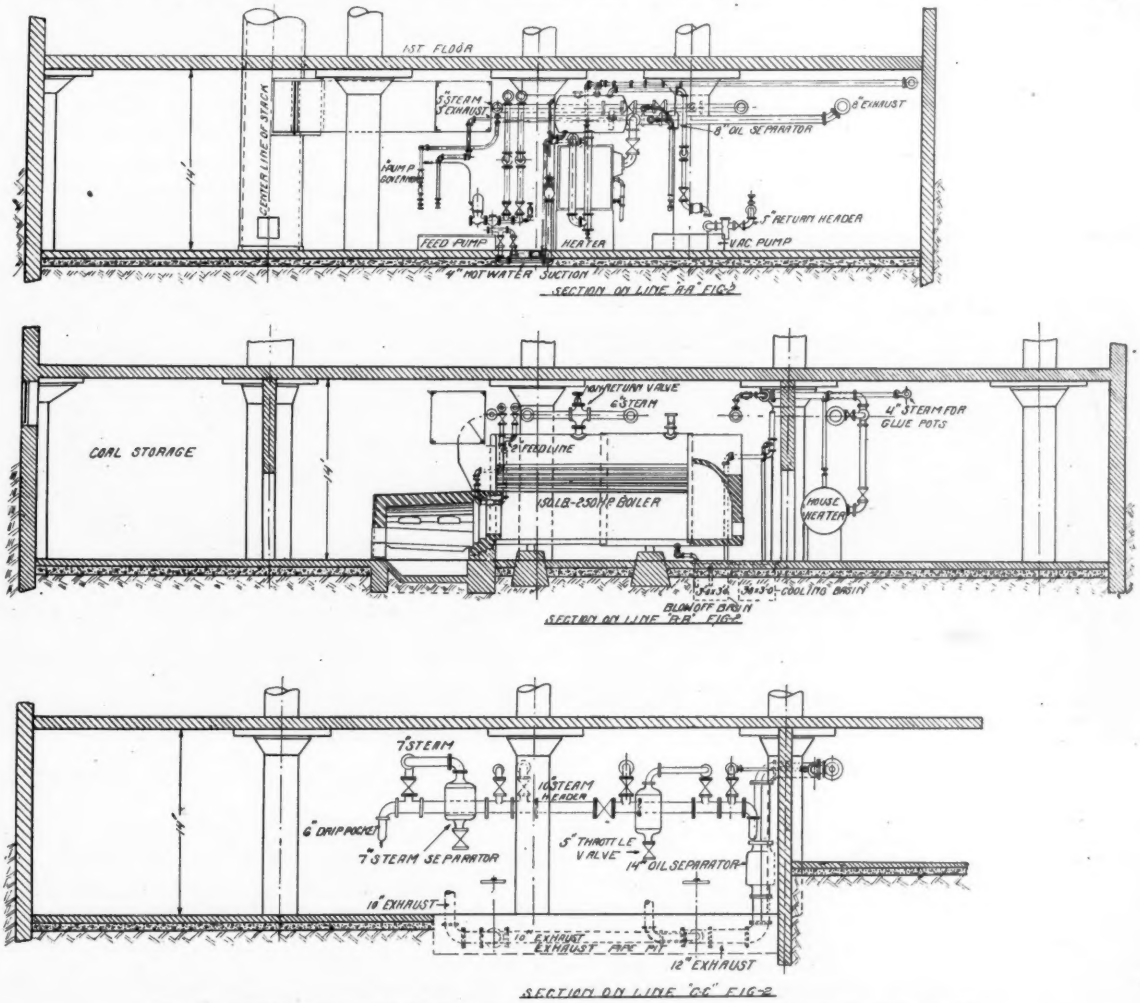


FIG. 3. SECTIONAL ELEVATIONS OF PUMP ROOM, BOILER ROOM AND ENGINE ROOM

capable of delivering 750 gal. of water per minute, and two 8 by 10 by 12-in. Blake & Knowles simplex vacuum pumps for use in connection with a heating system having 20,000 sq. ft. of radiation.

As may be seen by referring to Fig. 2, discharges from the two vacuum pumps and the high-pressure traps are piped through 4-in. lines to a receiving tank from which they flow into the feed-water heater through a seal consisting of a 7-ft. length of 6-in. pipe, as shown in Fig. 3.

Piping Layout

Differing from schemes often employed in installations of this size, the piping system is of the greatest

simplicity consistent with the highest degree of flexibility and reliability of service. Steam coming from the boilers is carried to a 10-in. header along the engine room wall by two 6-in. leads and delivered to the prime movers by 4 and 7-in. branches, the former to a 14 by 36-in. Quincy Corliss engine and the 7-in. lead to a 20 by 28-in. Chuse Corliss engine. Steam for the pumps and auxiliary equipment is taken direct by these units from a 5-in. auxiliary header of the ring type connecting with the main header as shown in Fig. 2, the general arrangement being such as to allow the cutting out of any section of the main header without interruption of service to either prime movers or auxiliaries.

Special precaution has been taken to eliminate the accumulation of condensation in the main header by connecting to each end of it a 6-in. drip pocket. Directly below the main header and mounted on the engine room wall are two Bundy steam traps, either one of which, by means of interconnections provided for the purpose, may care for the drainage of these pockets; the one not

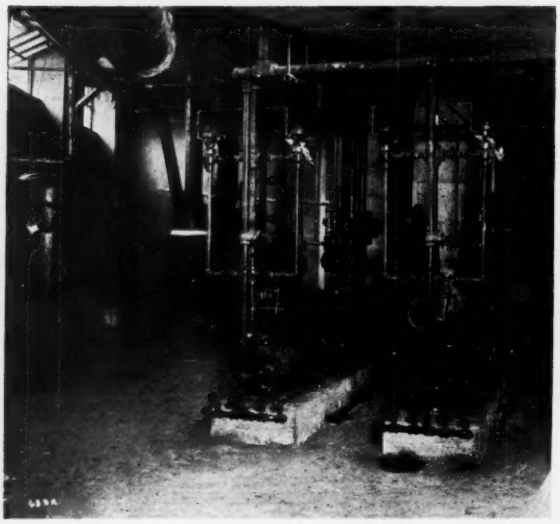


FIG. 4. BOILER FEED AND HOUSE PUMP EQUIPMENT

so employed handles the condensation from the engine separators.

Examining the layout of the exhaust header in Fig. 2, we find this to consist of two branches, one for the prime movers and the other for the auxiliary equipment. That for the engines is made up of 10 and 12-in. sections and is carried in a concrete trench below the engine room floor; that for the auxiliaries is in the form of the letter L and is made up of sections ranging in size from 3 to 10 in. Joining these 2 branches is a short 12-in. connection tieing in with 2 reducing tees, one of which by its 12-in. outlet serves the atmospheric exhaust line through a 12-in. Boylston back-pressure valve, while the 8-in. side of the other tee is tied in with the heating system by means of a valve of the same size. For the live steam heating supply a bypass fitted with two 4 by 6-in. Boylston pressure-reducing valves connects the 8-in. heating main to the main live steam header in the engine room, the first valve reducing the pressure from that carried in the header to about 85 lb., and the second valve from this to ½ lb.

The fire pump which is held in reserve for use in connection with the wet sprinkler system protecting the building from fire, is supplied with steam through a 3½-in. line connecting directly to the auxiliary header and is controlled by a 2-in. Boylston pump governor. And to insure against any possible interruption of service, the exhaust of this pump is connected to a 6-in. vent leading to the atmosphere instead of to the regular exhaust header. The suction is provided with a separate 6-in. line to the city water mains.

For use in connection with the sprinkler system there is installed in the tower of the building a wooden tank having a capacity of 25,000 gal., and so placed as to insure a maximum pressure of 45 lb. per sq. in.

Electric Generating Equipment

In the engine room which, as indicated in Fig. 2, is adjacent to the boiler room are the two main generating units, one of which consists of a 14 by 36-in. Quincy Corliss engine direct connected to a 100-kw. Sprague direct-current machine, while the other is a

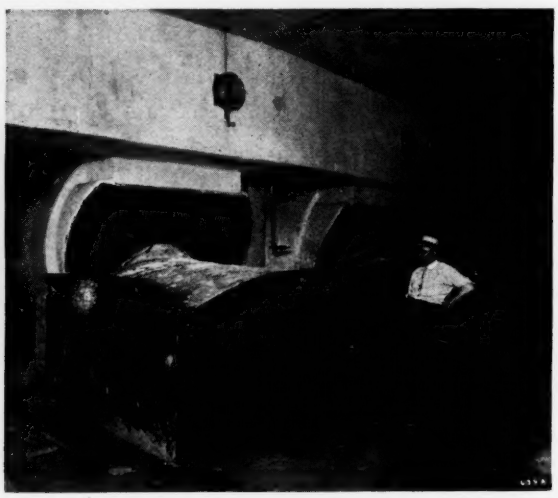


FIG. 5. CHIEF ENGINEER M'GINNISS IN FRONT OF BOILERS

20 by 28-in. Chuse Corliss engine of the non-releasing valve gear type driving a 250-kw. General Electric direct-current generator. The former operates at a speed of 110 r.p.m. and the latter at 150 r.p.m.; both generators are wound to deliver current at 220 v. at full speed and capacity.

Up to the present time the load has not reached proportions requiring the parallel operation of the generators, but due to the fact that an institution of this type is frequently in continuous operation for prolonged periods, the electric light and power generating equipment is many times subjected to severe tests demonstrating the reliability and durability of the machines. An instance of this nature recently occurred when, due to repairs being made on the smaller unit, the Chuse engine set was run for 3 months without shut-down, an unusual record for a reciprocating machine.

Generator and distribution control is maintained through a black slate switchboard made up of 2 generator panels, 1 balancer set panel and 2 distribution panels.

House Water Supply

Cold water for drinking and toilet purposes is taken from the city mains through a 4-in. branch, but before being delivered to the system is passed through a National filter having a capacity of 250 gal. per hr. The pressure maintained in the city water mains is sufficient to supply only the basement and the first and second floors; that for the third and fourth floors is taken from a 1500-gal. wooden tank located in the tower and supplied from one of the house pumps.

A heater placed in the boiler room, having a capacity of 1000 gal. and capable of delivering 750 gal. per hr. at a temperature of from 140 to 150 deg. F. heated by steam taken from the main exhaust header through a 6-in. branch provides all of the hot water required. Temperature of the water is controlled by varying the volume of exhaust steam entering the heater according to the demand for hot water. This is accomplished by means of a Powers regulator.

Original plans for the Henneberry building embodied no power plant, as it was the intention of the architect to install two low-pressure boilers to supply the necessary steam for heating and that employed in the manufacturing processes and to purchase all electric current for light and power. Strenuous objections were, however, raised to this proposal by J. E. McGinniss, chief engineer for The Henneberry Co., who convinced those in authority of the fallacy of such a procedure in an installation of this type. Commenting on the subject, Mr. McGinniss informs us that at the time this plant was placed in operation he was able to purchase coal at $1.90 per ton. Now he is paying over $3 per ton for an inferior grade of fuel, and even with an increase of fuel cost of nearly 100 per cent he states he can still successfully compete with the local central station company. Where, as in plants of this kind, large quantities of low-pressure steam are required for heating and manufacturing purposes, the generation of power is virtually a by-product and it is in installations of this nature that the field of the isolated plant cannot be legitimately invaded.

It is due to courtesies and assistance extended by Mr. McGinnis and Mr. W. G. Glover of the J. R. Kehm Co., heating contractors, that the preparation of this article was possible.

Injectors—II

Commercial Applications. Arrangement of Parts and Operating Details of Typical Commercial Injectors and Ejectors as Illustrated and Described Herewith, Will Serve to Show the Present Development of the Apparatus

ALL the joints of the Sellers Restarting injector are screwed, and its tubes do not depend upon the pressure of steam to hold them in place. The overflow is directly under the water branch and can be provided with a drip funnel and discharge pipe without springing or bending the other pipe connections.

Steam enters at the top and passing down through the steam nozzle, discharges into the overflow chamber, thence to the air, lifting water to the injector. Condensation of the steam within the combining tube creates a partial vacuum which raises the upper bushing against the draft tube and holds the lower bushing against the delivering tube, thus preventing the admission of air.

For all ordinary cases, this injector requires no adjustment and will operate satisfactorily at from 40 to 120 lb. steam pressure, water flowing from a tank or city mains. It is entirely automatic in its action, restarting instantly after a temporary interruption of the steam or water supply. This injector, which is supplied by Jenkins Bros., gives a good range of capacities.

Lunkenheimer Automatic Injector

This injector, manufactured by the Lunkenheimer Co. of Cincinnati, is designed to deliver a maximum amount of water 50 per cent in excess of rated capacity under ordinary conditions.

Figure 5 illustrates the relative positions of the parts. A is the steam tube, B the water-lifting or suction tube, C the combining and delivery tube, E, overflow valve, F, overflow cap, G, delivery cap, H, union ring, J, union tail piece.

With feed water at 75 deg. F., this automatic injector will operate under the following range of steam pressures and lifts:

Steam pressures from—	Lifts
20 to 160 lb.	2 to 4 ft.
30 to 160 lb.	4 to 8 ft.
40 to 140 lb.	8 to 12 ft.
45 to 100 lb.	12 to 16 ft.
50 to 90 lb.	16 to 18 ft.
55 to 80 lb.	18 to 20 ft.

For raising water from deep wells, mines, or pits, the Lunkenheimer ejector, illustrated in Fig. 6, has a wide field of application. Steam in discharging from tube E carries the water from the suction pipe into delivery tube G.

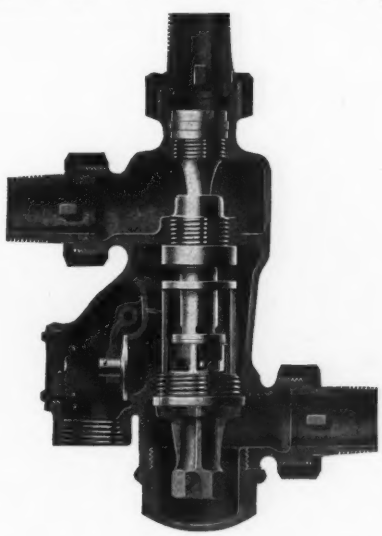


FIG. 4. SELLER'S RESTARTING INJECTOR

To start the ejector, the valve in the steam pipe is opened full until the flow of water is established, then the steam is throttled to as low an amount as the ejector will permit. With water at 75 deg. F., steam pressure of 50 lb., and a lift of 20 ft., the capacities of this instrument range from 250 to 11,000 gal. per hr.

Penberthy Auto-Positive Injector

While a large number of boilers carry less than 150 lb. pressure, the usual high pressure of the ordinary automatic injector, there is an increased demand for an injector that will operate between 150 and 200 lb. pressure. To supply this demand, the Penberthy Co., of Detroit, Mich., has manufactured, in addition to its automatic injector, a type known as the auto-positive injector.

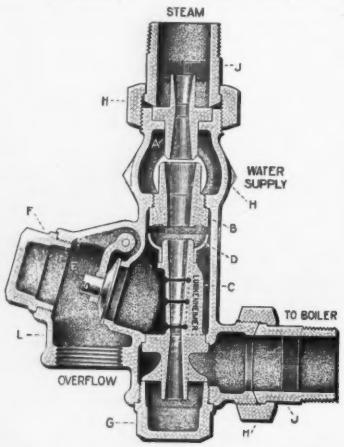


FIG. 5. LUNKENHEIMER AUTOMATIC INJECTOR

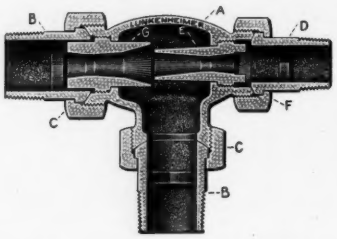


FIG. 6. LUNKENHEIMER EJECTOR

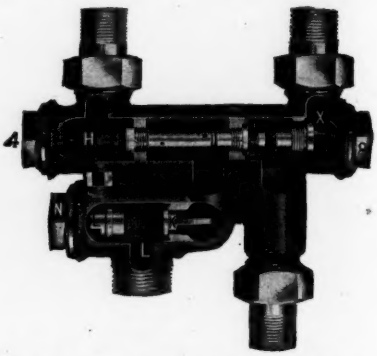


FIG. 7. PENBERTHY AUTO-POSITIVE INJECTOR

This instrument, shown in Fig. 7, combines the features of a positive with those of an automatic injector.

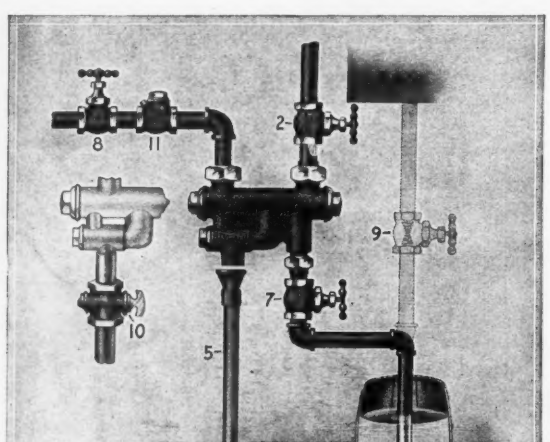


FIG. 8. INJECTOR CONNECTIONS

The usual upper overflow is used, but the combining and delivery tubes are made continuous, without spill holes or separating space. The jet, therefore, starts through the delivery tube, as the discharge chamber, H, has free access to the air when valve L is raised from its seat on bushing M whenever valve K opens. In starting the injector, steam is admitted through the upper right-hand branch to the nozzle, X, and in discharging through a draft-tube, produces a vacuum in the suction pipe. Discharging steam forces the automatic valve, K, against the end of the pressure valve, L, which is thus held open to permit free outlet of steam and water from the chamber, H. This is made possible by having the area of K about twice that of L. When the correct proportions of water and steam are admitted and the jet is formed, the pressure in the chamber containing the upper overflow is changed to a partial vacuum, which draws the automatic valve, K, to its seat and allows the pressure valve, L, to close, compelling the feed to pass through the check valve and into the boiler.

With water at 74 deg. F., it will start on a short lift at 20 to 25 lb. steam pressure and operate to 200 lb. pressure. A temperature from 40 to 60 deg. F. permits a range of pressures from 30 to 225 lb. and below 40 deg. F. it may operate between 35 and 240 lb. pressure.

By the novel arrangement of the valves of this injector, it can be operated as a positive injector, i.e., with a forcibly closed overflow. The drizzle from the overflow is stopped by placing stopcock 10, see Fig. 8, in a short piece of pipe in the overflow line, and closing it after the injector is started. A pressure of 235 lb. can now be carried with feed water at 75 deg. F., when

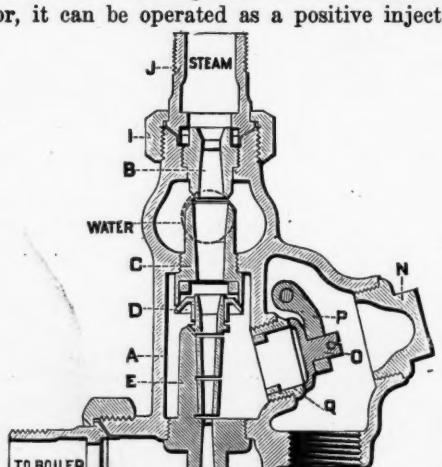


FIG. 9. POWELL AUTOMATIC INJECTOR

only 200 lb. can be carried without the stop-cock. This arrangement, however, should be resorted to only in extreme cases, as it renders the injector nonautomatic while the stop-cock is closed.

Powell Automatic Injector

In the design of the tapers and tubes of this injector, the Wm. Powell Co., of Cincinnati, has endeavored to prevent, as far as possible, the scaling up of the spill holes and other delicate parts, which insures a strong and certain automatic action. The seat of the overflow valve is independent of the main casting, into which it is screwed, and thus a superior alloy is used for the seat to secure a tight bearing surface.

Valves in the steam pipe and intake pipe are opened in starting the injector and until a sufficient vacuum is created by the passage of steam from the steam tube, B, see Fig. 9, to the suction tube, C, the flow of water around the combining tube, E, is relieved through a space between tubes C and E and the slots or holes in E. When a sufficient pressure has been created in the combining tube, E, to force water into the boiler, the flow through that tube creates a vacuum in the chamber, A, which seats the check valve, O. Should the flow be interrupted, water is again forced out the overflow until a sufficient pressure is restored in the combining or delivery tube.

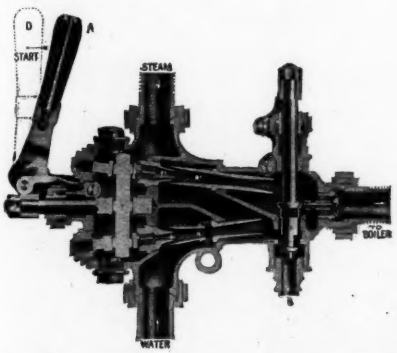


FIG. 10. UNIVERSAL DOUBLE-TUBE INJECTOR

Universal Double-Tube Injector

This injector, which is of the double-jet type, has no overflow in either the lifting or forcing combining tubes, as the starting of the jet is accomplished by direct communication with the air through the compound waste valve placed vertically over the nozzle, B, as indicated in Fig. 10.

To operate this instrument, which is made by the Schutte & Koerting Co., the lever is drawn from A to D, transmitting the pull to the valve over the lifting steam nozzle. As the valve of the forcing nozzle has a larger area, it is held by the steam pressure firmly to its seat, and acts as a fulcrum for the lever. After water has appeared at the waste pipe, B, the handle is drawn farther out, and the vertical overflow valve, connected with the starting lever by means of a rod and bell-crank lever not shown, cuts off the outlet of the first set and diverts the water through the forcing tube. The second steam nozzle is then opened by the continued movement of the starting lever, which during the latter part of its stroke, closes the waste valve; the jet then enters the boiler.

In the injector illustrated, the capacity is adjusted to the requirements of the boiler by means of a valve placed in the suction pipe; but recent improvements include a small taper spindle inserted in the steam nozzle of the lifting set, and adjusted by a handle directly under the starting lever. This arrangement makes it possible to vary the flow of steam in the lifting set, changing the amount of water delivered, and materially reduces the steam consumption at the minimum capacity. It is so arranged, however, that the lifting power of the injector is in no way affected, for the water can be raised and forced into the boiler even when the regulating valve is set for the lowest delivery of the instrument.

Eynon-Korting Compound Injector

Made by the Eynon-Evans Co., of Philadelphia, this injector, illustrated in Fig. 11, is started, regulated and stopped with one handle, a slight turn of which locks it in any position. To start, a slight pull of the handle

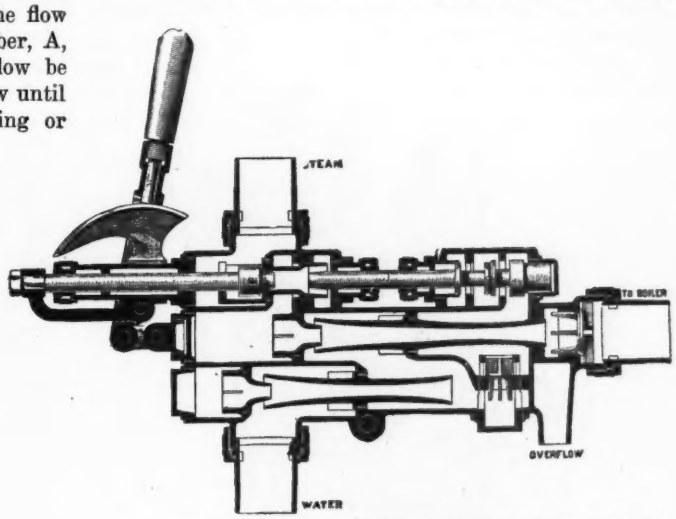


FIG. 11. EYNON-KORTING COMPOUND INJECTOR

permits steam to enter the lower nozzle. When water appears at the overflow, the handle is drawn back completely and the water is then forced into the boiler.

The quantity of water delivered by the suction nozzle to the forcing nozzle is in proportion to the steam pressure, so the first nozzle acts as a governor for the second and regulates the quantity supplied to the boiler.

With water flowing to the injector, or under a 4-ft. suction, and with a pressure of 60 lb., the temperature of the supply water may be as high as 150 deg. F.

U. S. Automatic Injector

Few operating parts are required with this injector, illustrated in Fig. 12, which is a product of the American Injector Co., of Detroit. It is adaptable to all-around service and may be operated under lifting or non-lifting conditions. When used non-lifting, an extra globe valve is placed in the suction pipe. With the tank or barrel situated just above the level of the non-lifting injector, it will start at from 1 to 3 lb. pressure, and with a water pressure of 20 lb. it will start at 10 lb. low and work to 180 lb. high.

Model X Metropolitan Injector

Both the steam and the combining and delivery nozzles of this automatic injector are screwed into the body.

Regulation of the quantity of water is accomplished by means of the valve in the suction pipe; the steam valve is kept open at all times when the injector is feeding.

With a lift not over 2 ft., and working with feed water at 70 deg. F., this model, which is one of the products of The Hayden & Derby Mfg. Co., of New York, will operate from 20 to 160 lb. steam pressure; with feed water the same temperature and a 20-ft. lift, it will operate from 55 to 100 lb. steam pressure; with feed water at 120 deg. F. and a lift of 2 ft., it will work from 30 to 85 lb. steam pressure.

The Hancock Inspirator

Inspirator is a trade name for an injector of the double-tube type which is manufactured by the Hancock Inspirator Co., of New York City.

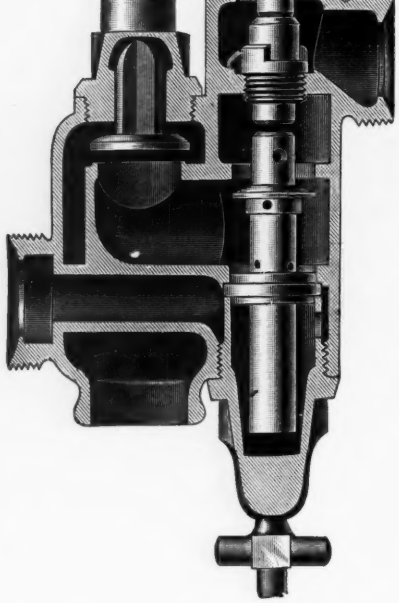


FIG. 12. U. S. AUTOMATIC INJECTOR

To operate, the overflow valves 1 and 3, as shown in the illustration, are opened. The forcer steam valve, 2, is then closed and the starting valve in the steam pipe is opened. When the water appears at the overflow, close valve 1 and open valve 2 one-quarter turn, then close valve 3. The inspirator will then be in operation.

No adjustment of either steam or water supply is necessary for varying steam pressures, but both may be varied by increasing or reducing the water supply.

When not feeding the boiler, the lifter side may be employed to deliver water to tanks or for other purposes.

In complete operation, water can be elevated about 2½ ft. above the inspirator for each pound of steam. With 45 lb. steam pressure, water can be lifted 25 ft. and elevated 112½ ft. above the inspirator, a total of 137½ ft.

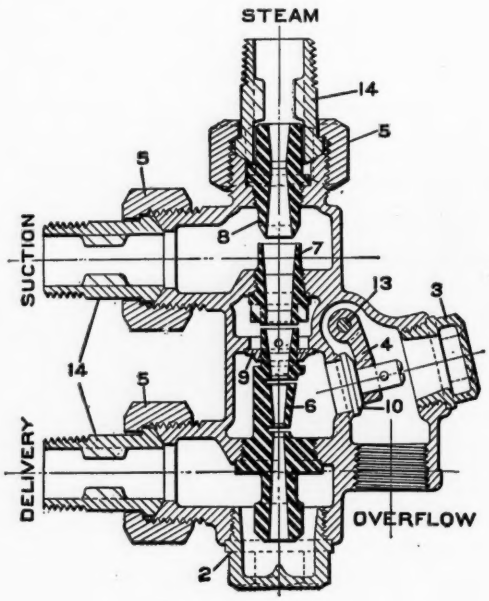


FIG. 13. MODEL X METROPOLITAN INJECTOR

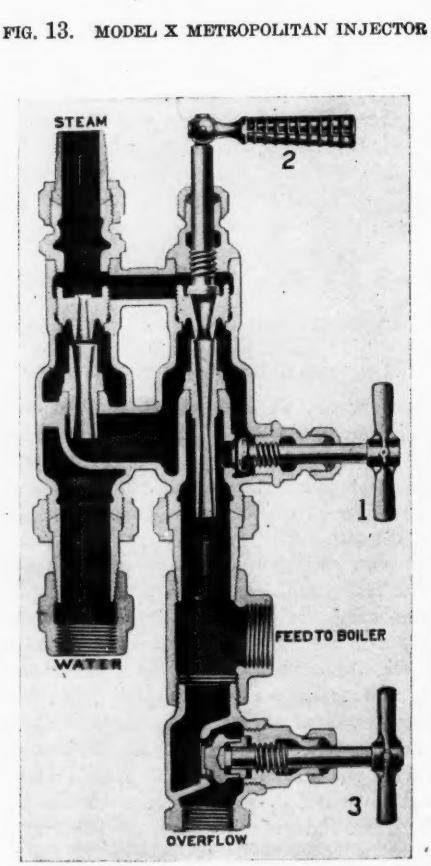


FIG. 14. HANCOCK INSPIRATOR

Action of Boiler Water Tubes in Service*

By John C. McCabe

DURING the past 20 yr. a boiler setting has ordinarily been considered improper if the boiler was set over 3 ft. above the grates. The general impression prevailing was, that if a greater distance between the boiler and grate were used, a great loss in economy would result. It has remained for the more adventurous and progressive engineers to depart from this practice so that at the present time, in boilers of 72 in. diameter, we find grate as far as 6 ft. from the boiler. With the increasing demand for smoke abatement throughout the United States and especially in the congested districts, mechanical engineers dealing with boiler matters have been forced to take radical steps to effect a cure of the smoke nuisance.

In connection with the relation of the furnace to the boiler it may be of interest to point out a few conditions observed by the author about a year ago concerning 2 Stirling boilers and a vertical Wickes water-tube boiler. Observations were made on boiler No. 14 in Station A of the Detroit United Railways to ascertain as nearly as possible what happened in the front tubes during the operation of the boiler. The boiler is the standard type of Stirling with 4 drums and 3 banks of tubes of 4 tubes to each and 19 tubes in each row and rated about 450 hp. This boiler was fitted with a Murphy stoker. It was observed that a permanent set of 2.5 in. existed in the tubes of the front row, with a maximum at 54 in. from the mud drum. New tubes were installed in place of a few defective ones and a bolt ⅜ in. diameter was welded to one side of a new tube in the front row and a ⅜-in. pipe was attached to this bolt. Circulation of water was maintained and kept at constant temperature. A record of the tube movement was communicated to the ribbon of a CO_2 recorder by means of the ⅜-in. pipe mentioned.

The boiler was fired up in the usual manner, and it was observed that the tube alternately moved toward the fire from its zero position and from the fire beyond the zero about 1/16 in., or a total movement of ⅛ in. This swing occurred every 4 or 5 min. As the water grew hotter the movement tended more from the fire, and when steam was formed the movement gradually increased to about ½ in. from the zero position and from the fire. This bending was opposite to the bends at each end of the tube, which were 8.5 in. on the bottom and 2.5 in. on the top end. The front tube was 17.5 ft. long and 3¼ in. in diameter. A rotation of one degree was measured on the lower drum. The boiler was operated slightly above normal rating. It was noted that the side of the tube farthest from the fire actually got the hottest, and this was a new tube and used for the first time under observation.

Observations were made on boiler No. 5 at the Packard Motor Company's plant. This boiler is a Wickes vertical water-tube boiler with tubes 22 ft. long and rated at about 400 hp. Observations were taken from a front tube about 10 ft. 6 in. from the lower drum. A piece of ⅜-in. pipe was attached to a circular plate which served to hold the pipe radial to the tube. Water was circulated and kept at constant temperature. The Murphy furnace was attached to this boiler in the usual manner. The boiler tubes were 4 in. in diameter and the deflection reached a maximum of ⅝ in. in this boiler. As in the case of the Stirling boiler just mentioned, the movement of this tube is away from the fire, and was proportionately about the same. It may appear that the force required to bend these tubes would be considerable. In the case of the 4-in. water tube, 187 lb. load at the center deflected the tube ⅝ in. with the ends free.

It is pretty well understood that subjecting boiler materials to usage that induces variable temperatures in parts of shells, tubes or drums, will eventually render such parts gradually less safe for use.

One of the serious troubles experienced in the operation of water-tube boilers is the rupture of tubes. Accidents of this kind are not at all rare and have been attended by loss of life and considerable damage to the boilers. Several experiments were made to determine, as far as possible, the conditions under which a tube will rupture and also bag or bulge.

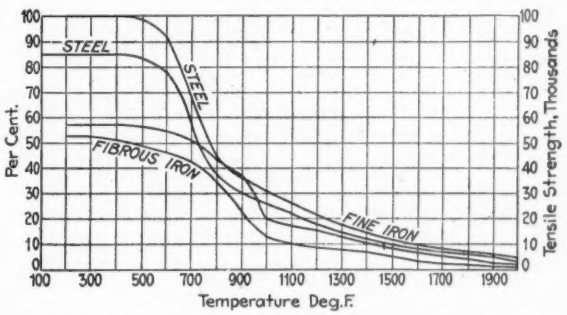


FIG. 1. YIELD TEMPERATURES OF STEEL AND IRON

In one test a 3¼-in. seamless steel tube 0.13 in. thick, having a tensile strength of 55,800 lb. and an elastic limit of 46,600 lb. was used, the elastic limit being 83.5 per cent. of the tensile strength. It was desired to ascertain at what temperature this tube would yield or take a deformation under an internal pressure of 200 lb. of air. Calculated from its elastic limit, a pressure of

$$\frac{2 \times 46{,}600 \times 0.13}{3.25 - (13 \times 2)} = 4052 \text{ lb.}$$

is indicated as the pressure at which this tube would begin to yield under a temperature of 400 deg. F. or less.

By the formula where

R = radius in inches, corrected for temperature
P = pressure in pounds
t = thickness in inches
E.L. = elastic limit

$$\frac{R \times P}{t \times E.L.} = \frac{1.514 \times 200}{0.13 \times 46{,}600} = 0.0499 \text{ per cent,}$$

or about 2000 deg. F. is indicated from the curves as the yield temperature. (See Fig. 1.) The 2000 deg. F. leaves only 5 per cent of the original strength of metal.

*From a paper presented at a meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

After the tube was heated to 2000 deg. F. with 200 lb. gage pressure, and then cooled, an increase of 3/32 in. was found in the diameter. Several similar tests were made with the same approximate results. These tests show clearly to about what temperature a cylindrical vessel must be heated before it will deform under a given pressure.

It was desired to cause an actual rupture in a 3¼-in. seamless steel tube in a manner similar to those of frequent occurrence in water-tube boilers. The tube selected was found to have a tensile strength of 60,800 lb., with an elastic limit of 45,800 lb. With a constant air pressure of 200 lb. kept on it, this tube was heated to 2000 deg. F. and quickly taken from the furnace and a stream of cold water shot on it for about one foot of its length. This process was repeated several times, but without result. Finally the tube was heated to 2100 deg. F. and it ruptured with a mild explosion, tearing longitudinally for 18 in. and opening 10 in. wide, the reaction bending the tube back. Figure 2 shows the ruptured tube and the tube tested to its yield point. The tube was heated to 1079.4 deg. C. (1975 deg. F.) with 200 lb. pressure of air, and upon cooling, the diameter had increased 3/32 in.

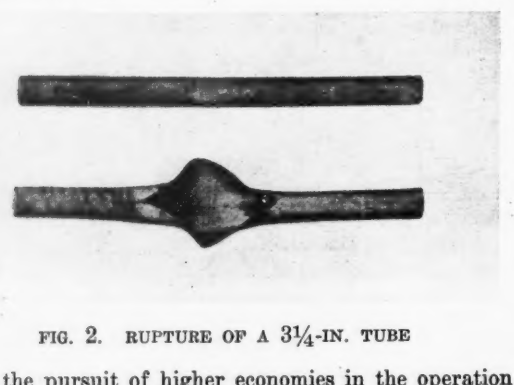


FIG. 2. RUPTURE OF A 3¼-IN. TUBE

In the pursuit of higher economies in the operation of steam boilers some engineers are placing the baffle back of the first row of tubes both in horizontal and vertical fire-tube boilers for the purpose of obtaining higher initial furnace temperatures. The result of this practice to the best of my knowledge has not been entirely satisfactory for the reason that the excessive generation in the front row of tubes has brought about repeated failures in installations where this method has been practiced.

It would appear to me from my observations as indicated by the foregoing that if the grates are kept at such a distance away from the tubes that the flames do not come in contact with the tubes, a lot of failures may be avoided. The high temperature necessary to deform a tube is clearly indicated by the illustrations.

BUSINESS IN fuel briquets in the United States has been increasing, the production in 1916 being 295,155 net tons, valued at $1,445,662. This is an increase of 33 per cent in quantity over 1915, and 40 per cent in value and an increase over the previous high record, which was for 1914, of 44,520 tons. Improvement in the burning qualities of briquets has also been effected, removing to a considerable extent the heavy smoke that was previously found objectionable in domestic use.

Efficient Oil Burning

PROPER AIR SUPPLY; FLUE GAS FRICTION; DRAFT CONTROL. BY A. C. MCHUGH

IN BURNING coal it is common practice, and necessarily so, to use 50 to 100 per cent of excess air; i.e., for each pound of air required in the process of combustion ½ to 1 lb. is added to insure sufficient oxygen to permit complete combustion. In order to supply the necessary air, considerable draft is required, being proportional to the resistance offered by the fuel bed, flues, dampers, breeching, etc. It is easily seen that a draft sufficient to supply the proper amount of air for a given condition will supply more than the required amount for the same condition should the resistance to the flow of air be decreased.

While the truth of the foregoing is generally accepted by all, it is surprising what little attention it is given, especially in the average small oil burning plants, which are, without doubt, more wasteful of fuel than the average small plant using coal, when in reality the reverse should be the case. The nature of fuel oil and the method of burning it permit of an easy and effective mixture with oxygen, and if air is supplied in the proper manner little more than the theoretical amount need be used. Cases are on record of tests run where only 10 per cent of excess air was used; but for average conditions, if the excess is reduced to 20 or 25 per cent and the proper amount of attention given to prevent the formation of CO and smoke, many thousands of dollars can be saved yearly, as it is not uncommon to see boilers operating with the flue dampers wide open and the ash pit doors open or removed entirely. While this condition may be advantageous if the boiler is being worked at full capacity (which is seldom in the average small plant) no particular attention is generally given to reducing the air supply in proportion to the requirements of the fire, with the result that from 300 to 500 per cent excess air is admitted. Suppose this air has a temperature of 70 deg. F. when entering the furnace and that a flue gas temperature of 500 deg. F. is maintained; this results in the temperature difference of 430 deg. It requires about 14 lb. of air to burn a pound of oil and 300 per cent excess air would amount to 42 lb.; thus, 42×0.24 (specific heat of flue gas) $\times 430 = 4334.4$, which is the number of heat units lost. Assuming a value of 18,600 B.t.u. per lb. of oil, this loss would amount to $4334.4 \times 100 \div 18.600$, or about 24 per cent of the fuel. By reducing the excess air to 50 per cent, which is possible in any furnace worthy of the name, this loss may be reduced to 4 per cent, thus effecting a net saving of 20 per cent. Suppose in any of these plants an oil pipe should start to leak to the extent of 1/5 the total oil used, how long would the management tolerate its continuance? Just about no time. Still, the heat required to heat the excess air constitutes a leak just as serious but not quite so obvious to the untrained eye.

While the theoretical amount of air required to burn a pound of oil is greater than that necessary for a pound of coal, the weight of flue gas for a given boiler capacity will be much less with oil than with coal. For instance, 14 lb. of air per pound of oil, add 7 lb. or 50 per cent for excess, gives 21 lb. plus 1 lb. of fuel, resulting in 22

lb. of flue gas. With a heat value of 18,000 B.t.u. per lb. of oil and a boiler efficiency of 75 per cent (which is entirely possible) for each 1000 effective B.t.u., we have $22 \times 1000 \div 18{,}000 \times 0.75$, or 1.63 lb. flue gas.

With coal, assuming 12 lb. of air are required per pound of fuel with 100 per cent excess air for complete combustion plus 1 lb. of fuel, gives 25 lb. of flue gas. Allowing a heat value of 13,000 B.t.u. and a boiler efficiency of 70 per cent; for each 1000 effective B.t.u. we will have $25 \times 1000 \div 13{,}000 \times 0.70$, or 2.74 lb. of flue gas. Thus it is seen that the amount of flue gas with oil is only 0.6 of that with coal, considering the same boiler capacity.

Now consider the resistance offered to the flow of the gases in an oil burning furnace where no fuel bed exists and where the injector action of the burners often creates a slight pressure in the fire-box; the resistance to be overcome by draft is thus greatly decreased from that existing in the ordinary coal fired furnace, and is made up of the frictional resistance of the boiler passes, dampers, flues, stack, etc. As a general rule, it may be stated that for a given boiler capacity the draft required in the combustion of oil fuel is about half that of coal, and with natural draft the height of the stack may be reduced in proportion. The cross section may also be reduced 40 per cent to correspond with the reduction in the amount of flue gas passed.

It would be advantageous, in most cases, to discontinue the practice of equipping oil fired boilers with stacks designed for the use of coal. Using a smaller stack would slightly reduce the first cost and greatly lessen the possibility of operating with a great excess of air. At the time of the big earthquake in California in 1906, many oil burning plants had the height of their stacks greatly reduced without experiencing any difficulty in operating at full capacity, and in some cases with improved fuel economy.

The benefit to be derived through the use of flue gas analyzers is as great with oil as with coal, possibly more so; but an analyzer should always be used in conjunction with draft gages, of which two should be used on each setting, or one connected so as to give readings at two different points, viz., on the boiler side of the flue damper and in the fire box. As the resistance offered to the flow of gases between these two points is constant, the draft will vary only with the rate of gas flow and is independent of the method of air supply control regardless of the means used, which vary according to the opinion of the operator, some using the ashpit doors only, others the flue damper only, and still others a combination of both. The two last mentioned may be considered good practice while the first, although common, is to say the least, a very poor method, as placing the main draft resistance at the ashpit doors virtually converts the entire boiler setting into a vacuum chamber; thus greatly increasing the infiltration of air through the settings, causing a loss which would be of small consequence were the settings reasonably tight and the flue dampers used exclusively. As oil contains a large proportion of volatile matter the maximum CO_2 possible is much less than with coal high in carbon, and rarely exceeds 16 per cent; while, in actual practice, the carrying of 12 or 13 per cent CO_2 with no CO would be considered good practice, as the excess air loss would amount to but 3 or 4.5 per cent.

Another point often overlooked in the operating of oil fired boilers is that of soot formation. In a book published by one of the leading manufacturers of soot blowers the statement is made that the matter deposited upon the tubes and plates of a boiler, using oil fuel, is made up entirely of true soot.

Points to Watch in Compressors

"THERE is an explosive hazard involved in air cylinders that is not very generally appreciated, and to guard against this particular attention must be given to the internal lubrication of the cylinders and to the circulation and temperature of the cooling water," says W. P. Eales, Supervising Inspector, The Travelers Insurance Co.

"Steam cylinder oil should never be used in air cylinders. There is an intense dry heat in air cylinders, while in steam cylinders moisture is usually present to some extent. Oil will adhere to a dry surface when it would wash off of a similar surface that is moist or damp, and for this reason a smaller quantity of oil than is necessary in steam engines is sufficient in an air-compressor cylinder.

"A pint of air-cylinder oil should be ample for a 12-in. cylinder for 24 hr. running. It is sometimes difficult to adjust a gravity lubricator to this fineness of feed, and hence for this purpose forced-feed mechanical lubricators are recommended. There is danger, however, in using too much oil in air cylinders.

"At a pressure of 100 lb. the temperature in an air cylinder often reaches 400 deg. F. on account of interruption in the circulation of the cooling water, and owing to the likelihood of exposure to this intense heat the cylinder oil must be of such a nature that it will not volatilize nor form a coating of carbon or burnt oil around the discharge valves and render them inoperative. This condition is encountered in small compressors, the discharge valves of which are usually actuated by springs only.

"The carbonized matter in the cylinder oil, liberated by the application of heat and deposited in the air passages and in and around the valves, may be removed quite well by the application of soapsuds or soapy water. Kerosene oil should never be used for this purpose. It becomes necessary in some cases to remove the valve bonnets once a week, to clean out the ports and passages.

"In some installations, fusible plugs are provided in the bonnets or parts adjacent to the discharge valves to relieve the pressure in case the temperature reaches 500 deg. F.—the danger point. This is a wise precaution, and plugs of this kind should be adopted more generally. Self-oilers are advisable for the various external working parts of air compressors."

IT WOULD SEEM the wiser policy to leave the adoption of the metric system optional, as we and our American cousins have done hitherto, till the civilized nations have agreed upon a really correct unit. Anyone who travels in the countries where the metric system is in force knows that in common practice it is not universally adhered to, but that the old measures and weights are still used by the masses.—The Engineer, London.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Lighting of a Modern Office Building

SEMI-DIRECT FIXTURES FOUND MOST FAVORABLE FOR GENERAL OFFICE LIGHTING BY COMMONWEALTH EDISON CO.

HOURS of detail work with printed or written pages, day after day, are sure to have a tiring effect upon the eyes even under the best lighting conditions. Haphazard arrangements of lights should have no place in office buildings; but too many building superintendents and office managers are content with "sufficient" light without proper regard to arrangement, distribution, color and the general effect upon the eyes of those who are compelled to work under it.

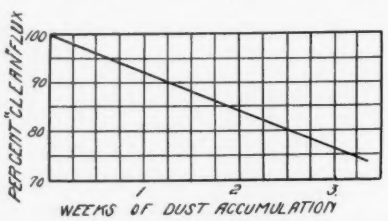


FIG. 1. DUST ABSORPTION FACTOR OF STANDARD SEMI-DIRECT OFFICE INSTALLATION

One of the causes for this lack of attention to lighting conditions is the lack of general knowledge as to what constitutes good lighting and how it can be attained. Scientific lighting by artificial means is new; but during recent years, great strides have been made to standardize conditions, improve lighting fixtures, study

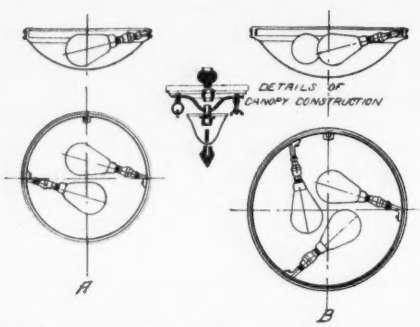


FIG. 2. SCHEME OF FIXTURE CONSTRUCTION

effects upon eyes of various types and conditions of lighting, and otherwise advance the science.

Among the recent examples of scientific artificial lighting for office buildings is that of the Edison Building in Chicago. This building, which was acquired a few years ago by the Commonwealth Edison Co., has been largely remodeled, and after a thorough study of conditions, the lighting system was changed entirely, with the result that most satisfactory conditions have been secured.

As a result of preliminary tests, the superiority of the semi-direct and indirect systems over the direct in lessened eye fatigue and in harsh shadow elimination seemed to the lighting committee which had the work in charge to overbalance greatly the decreased utilization efficiency, lessened uniformity and increased investment of those more diffusing systems. As between the semi-direct and indirect systems, the committee recommended the semi-direct, with the provision that semi-direct and indirect units of closely similar design should

FIG. 3. (a) STANDARD SEMI-DIRECT UNIT (b) BOWL OPENED FOR CLEANING

be developed and that each department head should decide which should be installed in the offices under his direction. This parallel design was carried out and the indirect system chosen for the drafting room, where all agreed that the minimum glare on the tracing cloth made it ideal, and for about 5 per cent of the offices. In other offices the semi-direct system was installed.

The necessary characteristics of a satisfactory semi-direct unit were considered to be (a) Bowl brightness not more than three times that of the ceiling, (b) Rea-

sonably high overall efficiency, hence a high reflection coefficient for the bowl interior and little interference from fixture structure, (c) Color modification of tungsten flux to a warmer tone, (d) Easy cleaning of bowl and lamps.

The bowl finally chosen met all the requirements satisfactorily. The bottom was 2.7 times as bright as the brightest spot in the ceiling and the side of practically ceiling brightness. The depth, 6½ in. for a 20-in. bowl and 5¼ in. for a 16-in. size, conduced to this

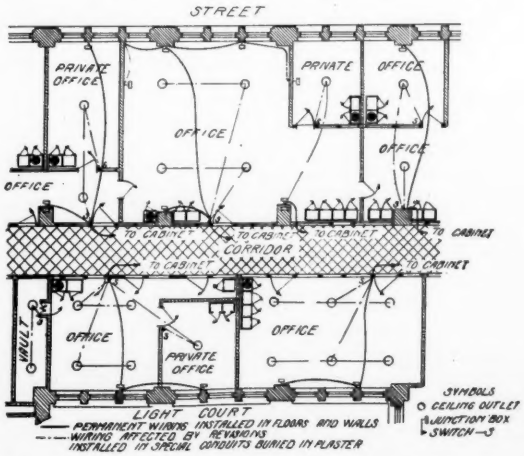


FIG. 4. TYPICAL INSTALLATION OF OVAL DUCT CONDUIT

result; but the density of the triple-cased glass used was the principal factor. The standard suspension of the bowls is 30 in. from the ceiling, but this varied some with ceiling height and spacings.

The office floors of the Edison Building are arranged on 3 sides of an oblong court 60 by 120 ft. in extent, and a central corridor divides a considerable part of each floor into an inner and outer space. This arrangement leads to 3 groups of offices approximately 20, 30

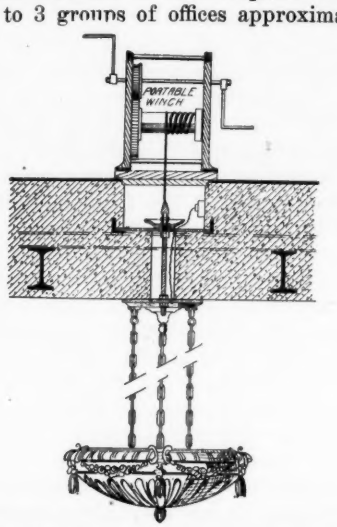


FIG. 5. LOWERING DEVICE FOR LARGE ELECTROLIER

and 56 ft. in width, many of the general clerical spaces being comparatively long, while the private offices average 15 ft. square. The ceiling height varies from 10 ft. 1 in. to 17 ft. 3 in., 44,000 sq. ft. or nearly 54 per cent of the total floor area having a height of 10 ft. 9 in.

Variation in the spacing of the semi-direct units was necessitated by the considerable range in width of offices. Fourteen feet between centers was taken as the maximum and this distance was considered standard, although spacings as low as 8 ft. were used in a few cases. In general the shorter spacings were employed in private offices and units with 16-in. bowls installed carrying 2 or 3 60 or 100-watt tungsten lamps, the standard outlet capacity being 1½ watts per square foot of floor space.

All offices were decorated with cream and brown tints of calcimine, and after 6 mo. of use, the reflection coefficients were found to be about 0.8 for the ceiling and somewhat above 0.7 for the walls.

Extra care was used in securing the data for the dust deterioration curve, Fig. 1, and the plotted prints from 3 locations representing the most dusty offices in the building showed no departure from the straight line law during the observation period of 3 weeks. As the absorption had increased to 25 per cent at that time, a bimonthly cleaning schedule was recommended to insure an illumination at all times above 80 per cent of the clean bowl condition.

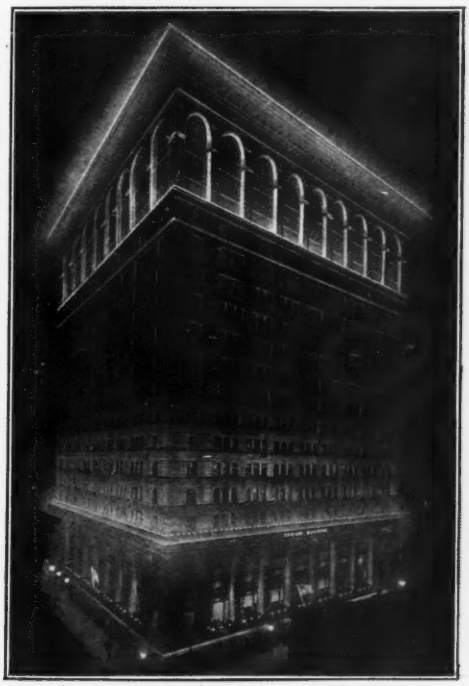


FIG. 6. EDISON BUILDING AS SEEN AT NIGHT

Special care was taken in the design of the fixtures to place the lights in the bowl so that a uniform appearance is secured. Figure 2 shows the arrangements for the 2 and 3 light fixtures.

In making the rearrangements of lighting fixtures, which investigations proved advisable, use was made of oval duct for wiring subject to revision. Oval duct is a flexible steel conduit which may be buried in plaster without the necessity of breaking into tile partitions or the lath of ceilings. Permanent wiring is, as usual, installed in rigid conduit. Figure 4 shows how oval duct is used in connection with rigid conduit.

In the main corridor a magnificent electrolier is suspended from the ceiling and the problem of lowering this for cleaning presented some difficulties which have been worked out in the manner shown in Fig. 5. A

marble slab carried in a brass tray closes the hole in the marble floor above.

The second-floor lighting is accomplished by means of semi-direct brackets, and the illuminated skylight. The bowls in the semi-direct brackets are of special shape to direct the light into the center of the bays, the front edge being higher than the back, so that the light is kept out of the line of vision of the people on the third floor; 500-watt type "B" lamps are used in these fixtures.

The lighting of the skylight is accomplished by means of type "B" lamps and dome shaped enameled steel reflectors. Three sizes of lamps are used, namely 60-watt, 100-watt and 150-watt. These are placed at varying heights, due to the hip roof construction; 128 60-watt, 122 100-watt and 38 150-watt lamps are used, together with 76 25-watt around in the border grilles. All lamps are a special amber glass made to order to match as near as possible the prevailing amber tone of the Calcite glass.

Exterior Lighting

The exterior lighting of the Edison Building has been done by a combination of outline lighting and flood lighting. Beginning at the sidewalk level, the first units are installed under the ledge at the second floor. These are so arranged that they are not visible to the passerby and illuminate the lower face of the building and the sidewalk. The lighting consists of 40-watt lamps on approximately 8-in. centers, making a total of 570 lamps. Above the ledge are 54 projector units placed three in a bay, flood lighting the lower columns and cornices. These units use 250-watt concentrated filament projector lamps.

Under the ledge at the fourth floor level, 15-watt lamps are installed on 4-in. centers, or about 1150 lamps in all. On the ledge are 125 250-watt projecting units to light the face of the building and the underside of the roof cornice.

The outline lighting at the sixteenth floor ledge consists of 25-watt lamps on 6-in. centers; 800 lamps in all, and 54 250-watt projectors at the sixteenth floor to light the upper bays.

The roof lighting consists of 100-watt type "C" Mazdas, spaced on foot centers; 400 lamps in all.

All work on the outside of the building has been done by means of copper trough, with the exception of the roof units, which are conduit construction. All exterior lighting is controlled at the main switchboard.

Material for this article was secured largely from a paper presented before the Illuminating Engineering Society by Wm. A. Durgin and J. B. Jackson; additional data, however, was secured from Mr. Jackson, engineer of lighting service for the Commonwealth Edison Co.

Electric Elevator Maintenance

Hints and Suggestions Relative to the Prevention and Remedy of Troubles Tending to Arise. By H. J. Geake

THE brake of the electric driven drum type elevator which acts upon the enlarged coupling of the motor shaft, consists of a solenoid actuating a piston, which in turn imparts motion through a suitable system of levers to the brake shoes or band as the case may be. The rubbing or contact faces of these shoes or band are lined with leather and care should be taken to supervise carefully the wear of this, for should the leather wear down and allow the 2 metal faces to form a rubbing contact it will score and spoil the rubbing or braking surface of the coupling and may even necessitate dismantling and machining to a fresh working surface.

The brake should be kept clean and no oil should be used upon the faces. If a brake is working noisily due to new leather or on extra high polish, the least wipe of common yellow soap will be found to help considerably and has the advantage of providing lubrication without softening the leather which would thus become like a sponge absorbing and retaining dust and dirt and eventually resulting in a scored brake.

Like all other electric machinery cleanliness is essential. As cleaning a machine brings us in intimate contact with its working parts we are bound to notice loose parts should there be any, and as fully 50 per cent of the troubles incidental to elevator control can be traced to and placed upon this one fact, we can easily see the value of the old adage, "a stitch in time saves nine."

On the control board is mounted an automatic switch, called the potential switch, 2 large solenoids, one each respectively for up and down, 1 large solenoid actuating 4 or more lever armed contacts, called accelerators and 1 magnet controlling full speed. The potential switch is an automatic appliance actuated by a solenoid or magnetic coil whose duty it is automatically to disconnect the machine from the source of supply of current, should the current at any time fall below or rise above a predetermined safe voltage, or should the car rise above the normal travel of top or drop below the normal travel at bottom of shaft.

There is also a switch in the car with connecting wires leading to the potential switch. Should at any time the car operating switch get out of order and the attendant be unable to stop the car at floor required, this connection will enable him, should he so desire, to break the circuit and stop the car.

This potential switch has 3 blades, 2 at the top and one at the bottom. The 2 contact faces of this switch (top half) consist of a brass contact plate on the switch leg and a carbon contact on the line connection. Attention is particularly drawn to this combination as under no consideration should metal to metal contacts be made, for such being substituted should the metal arc, the switch might seize and either put the machine through the overhead works or drop it into the pit.

The third or lower arm on this potential switch is connected by suitable means to about the middle of the starting resistance. By this combination should at any time the switch trip when running either from high or low voltage or being tripped by safety devices before mentioned, this action will cause the breaking of the main circuit, releasing the brake and short-circuiting the armature through this given amount of resistance. This short-circuiting, as is well known, acts as a brake on the motor.

In the car is placed the car-operating switch, consisting of a round cast-iron box fully insulated in which

are the contact fingers for completing the circuit which energizes the large solenoid situated upon the control board and according to direction moved, causing the car to ascend or descend, as the case may be. At the back of the control board (top half) will be found several resistance coils. These form a part of the circuit taken between the main line current and the solenoids actuating the contacts. The connections of these must be carefully watched, as, if any of the wires are broken or make poor contact, it is easily seen that the contacts would fail to act, and until this was remedied the machine would be stalled.

A fruitful source of trouble, especially if the machine is exposed to atmospheric influences, is that which tends to make the steel parts "sweat," particularly the solenoid plunger rods, causing a light scale of rust. As the clearance is so small between the rod and spool through which it works, the least deposit of rust will cause one of those "mysterious" bucking spells to which an elevator is heir. It is a safe plan to remove these spindles about every 3 months and wipe them with vaseline.

The carbon contacts of the main solenoids must be carefully watched to see that the wear is fully compensated, viz.: both carbons must break (separate) uniformly, as it will be readily understood that unequal separating will leave one carbon in contact and the second arcing. This practice will be found not only expensive on account of renewals of carbon and brass contacts, but there is always the danger of a heavy arc leaping to, and establishing contact with, some of the other metal parts mounted upon the control panel. The carbons are clamped in a receptacle which in turn travels upon 2 studs which form a component part of this mounting. Two springs sliding upon these studs and bearing between the base of stud holder and back of the carbon contact holder have a tendency to force the contact out against 2 or more washers upon the other end of the stud. These washers are held in place by a split pin and by adding to or subtracting from these washers the 2 contacts may be kept in perfect alinement.

It may not be amiss to consider here a prolific source of trouble in connection with the car control. As already stated, the electric contact to energize the solenoids are made in the box of the car. These contacts are mounted upon a flat metal spring whose function it is to keep good contact between the component parts. Now, since these springs must of necessity be light to obtain the desired resiliency it also follows that as they are flexed each time the handle moves, it is only a matter of time, figuratively speaking, before one or more of them fail or break. The failure of this section will result as follows: Should the first, viz., slow spring, contact break and fall clear, the car could not start. Should the second or last speed break, it naturally follows that the car would not go in full speed. Should, however, the spring break, and not fall clear the contact may close enough "to arc over" or to form circuit by burning. This will result in a rapid, jerky action of car and under certain conditions the car will fail to stop and continue either up or down until the limit switches are tripped, hence in case of trouble it is just as well to look at this combination before deciding to dismount a lot of board mountings. It will be found to save time, besides being less laborious.

Another source of trouble frequently arises from a "short" in the control cable. This cable consists of 5 or more wires, according to design, and it can be readily seen that if any of these wires form a contact independent of the control switch that the car will again run itself either up or down to the bottom of the shaft until the limit switches act, throwing the potential switch and breaking the main circuit.

We will now consider the machine safeties or stops. This combination consists of a nut traveling upon the threaded end of the cable drum spindle. This nut moves along the spindle a predetermined amount when a dog cast integral with the nut engages a casting which in turn is free to revolve within certain limits of travel upon the end of drum spindle shaft. This casting or yoke transmits motion through cogged wheels to 2 or more switch arms or contacts. These contacts form part of the solenoid actuating circuit and are so arranged that when the first part of the motion caused by the yoke engaging with the nut stop occurs, the first set of contacts are disconnected and the machine is thus automatically brought down to half speed; this action generally occurs approximately 8 ft. from bottom or top landing and the second set or full motion of this yoke will throw out or disconnect the second or final set of contacts. This will, under normal conditions render the machine inoperative from any further travel in direction above top or bottom floor level. Attention must be given to this part of the machine to keep it properly adjusted, as it will be readily seen that any stretching in the car cables will have the effect of making the machine stop short of the top landing and consequently, the relative travel remaining the same, the car will fail to stop flush with bottom landing and thus the limit switch be tripped and the car rendered inoperative.

In conjunction with the foregoing it may now be advisable to deal with these limit switches. They are 2 single carbon contact switches placed in series relative to each other and set or supported (generally in the pit but sometimes overhead, according to convenience for accessibility) so that when the car comes down to a pre-determined point, some part of the bottom of the car will come in contact with one leg of the lever of this switch thereby forcing the carbon contacts apart, thus breaking the circuit through the potential switch and disconnecting the line terminals from their source of supply.

It is always advisable when doing any adjustments above the machine to disconnect the main line switch and thus leave the machine dead, as by an accidental throwing in of one of the contacts or possibly touching a live part with a tool or wrench the person doing the adjusting would be liable to a bad burn.

Treat the motor the same as you would any other type; keep the commutator clean and maintain a proper spring tension on the brushes also (and this is important) pay particular attention to the rate the brushes wear down so as not to allow the brush holders to come in contact with the commutator. Check oil wells weekly at least to see that there is sufficient oil in them to allow rings which oil shaft to receive their necessary amount of lubricants without having enough surplus to splatter oil over the insulated parts.

On the gear case casting will be found 2 small hand holes with cover plates. The top plate when removed will allow inspection of the worm gear, and it is a good

plan to examine it at frequent intervals, as no matter how carefully the gear castings may have been cleaned in the foundry, occasionally there is a small pocket filled with sand, and if this should occur, the sand that would be held in suspension in the body of the oil would have anything but a beneficial effect upon the brass gear wheel. The lower hand hole is to examine the worm, but care should be taken to see that the oil in gear case is below this level before removing plate or there will be, to say the least, an unnecessary waste of oil.

The stuffing box on worm shaft should be just loose enough to ooze oil while the shaft is in motion. This will prevent the packing burning and keep it resilient over a much longer life. Use flax packing for this bearing. If trouble is experienced in keeping this bearing reasonably oil tight the fault may be that the shaft is slightly out of line. Try twisting the coupling to the next hole, as a slight burr may be causing the trouble. The fault may also lie in a bent stud which will cause a cocking of the gland. A close inspection will reveal if this is the trouble. Oil the machine a little at a time and frequently, as a drop on the spot is worth a pint on the floor.

Keep the overhead bearing boxes filled with a good grade of grease and make up any usage at least weekly when all bolts to bearing and cross bars should be tried for slackness and tightened up if so found.

Test all the safety appliances weekly and see that they are in good working condition.

Should the car refuse to start under a normal load, examine the fuses and do not depend upon the "recorder," that small green patch which is supposed to indicate if a fuse is blown. It has been the writer's luck, ere learning by sad experience, partially to dismantle some of the board and after all of this unnecessary labor to find that although apparently "good," the fuse was "dead." Examine closely for a broken main wire or connection to magnets, as the constant bending action has a tendency to break them.

If car has operated the limit safeties see that they are clean and not hung up. If they should fail to form contact the potential will not stay in.

Examine slack cable safety and see that there is no slackness in the internal connections and no wires broken.—The B. C. Stationary Engineer.

A Talk With a Chief Engineer

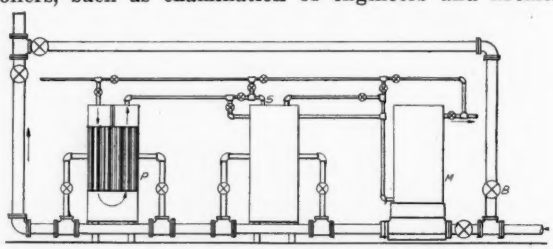
ON TESTING AND INSPECTION OF STEAM BOILERS, ALSO BOILER FEEDING. BY WM. KAVANAGH

KINGSLY, having read in the daily papers about an explosion of a steam boiler in a new power plant, decided to call on the chief and have a talk with him on the matter, and if possible learn the chief's opinion on boiler explosions, etc. When Kingsly entered the chief's engine room he found the chief busy reading an account of the latest boiler explosion. The newspaper said that a "200-ton boiler exploded with great force and wrecked the surrounding neighborhood." The chief was laughing at the account, and how the reporter for the newspaper knew the boiler weighed 200 tons.

After Kingsly greeted the chief he took a chair and having seated himself close by, started the following question:

"I would like you to explain the best and most approved method for testing and inspecting steam boilers so as to prevent as far as possible such terrible explosions."

In answer to this, the chief said it was an exceedingly difficult question to answer offhand satisfactorily; but if boilers were to be tested and inspected as the chief would require, he thought very few explosions would happen. "For my part," began the chief, "I would require both forms of test to be applied; the hydrostatic test will disclose what the hammer test is not capable of finding and the hammer test when properly applied is very efficient in locating loose braces, corrosion, thin or worn sheets, worn tubes, blisters, choked feed and blow pipes, gage cock and water column connections, etc. Of course, Kingsly, you are aware that in this town the engineers have charge of the testing and inspection of steam boilers, and for this reason we never have had any explosions since the law was changed permitting engineers only to do the testing and passing of the necessary rules and regulations regarding operation of steam boilers, such as examination of engineers and firemen



METHOD SUGGESTED FOR HEATING BOILER FEED WATER

before they are permitted to raise steam and operate a plant and also the limit of pressure to be carried."

At this point in the chief's discourse, Kingsly asked him what effect cold or partly cold feed water had on boilers. "You see," continued the chief, "when cold water is fed to a boiler along or close to the crown or fire sheet, the metal in the vicinity of the cold water becomes crystallized and brittle and is therefore highly dangerous. Cold water should never be fed to a boiler. I have invented a new method of heating water before feeding it to boilers, which invention I have not patented; but in the near future you will find this method employed to a large extent on account of the great saving to be realized in the use of fuel." Here the chief drew the figure as shown and continued. "This sketch illustrates what may be called a series multiple feed water heating system; the object is to elevate the temperature of the feed water to the highest possible point without causing back pressure. You will notice how the heaters are connected and how the feed water can be filtered in each heater before it enters the main heater or boiler. You will also notice the coldest water meets with the coldest exhaust steam and the hottest water meets with and absorbs the heat from the hottest exhaust steam. The primary or first heater is shown at P and it is open to show the means adopted to filter and at the same time heat the feed water. The water, after passing through the primary, enters the secondary heater at S where it is again subjected to filtration and elevation of its temperature. From S, the water is fed into the main heater, M, where its temperature is elevated to the

hottest point with exhaust steam. The bypass at B enables the cutting out of the entire system for repairs or cleaning.

"You will also notice that the heaters can be cleaned and repaired independently of each other while the system is in operation; by tracing the system or plan of piping on top of the heaters, you can see how this may be done. It is a simple matter to cut out either P or S and still have the feed water enter M, thus insuring hot feed water whenever exhaust steam is to be had, and if exhaust steam is not at hand it is a simple matter to make a live steam connection to the system which will insure hot feed water when the engines are shut down."

The chief said that this system was very economical because the feed water was raised to a high degree of temperature, thus requiring less fuel.

Some Experiences of a Boiler Inspector*

By Robert J. Huddleson

As old as the use of steam itself is the use of vessels for generating steam under pressure, and for just that length of time there have been boiler failures of different kinds.

Good design, good workmanship, regular effective and thorough inspections constitute a part of good management that is quite essential. It is certain that a good boiler is practically safe for all time in the hands of a good engineer or fireman, provided the boiler is originally well designed, well constructed and properly set. Its safety is assured by a correct system of inspections which will serve as a check upon every defect of design, of construction and of operation. Workmanship on present boilers has been greatly improved as compared to the early methods of drifting the rivet holes until it was possible to force the rivets through; and it is no longer considered possible to set the sheets up loosely and expect the calking tool to cover the poor work and make the boiler tight for the time being.

I have seen hemp and white lead used in seams, the same as one would calk a boat, in place of setting the plates up in proper manner. I have also found longitudinal seams partly single and partly double riveted, and on new boilers butt strap joints designed so that the efficiency was not equal to that of a lap joint, single riveted.

It is not uncommon to find butt joints with the edges of the plates about 14 in. apart, with the inside strap looking like the half sheets on a boiler. The only excuse the builder could find was that he did not have any plate large enough, so he used short plates, believing the inspector would pass or overlook them; but the inspector did not, so the case was taken into court and the inspector was sustained on the one word *butt joint*. Of course the boilers had to be replaced with new ones.

I tested out in a boiler shop 4 new boilers, of the 6-in. tube type, which are difficult to make tight. On applying the hydrostatic pressure, I found no leaks whatever, but when the boilers were emptied out and I went in, I found about a barrel of horse manure in each boiler. The boilers were ordered thoroughly cleaned and a new test was made. Four days later they were tight enough to be accepted. I mention these things merely to show what an inspector has to contend with in shop inspections.

An order was given to make an inspection of a battery of boilers in a blast furnace which were not giving proper results. Upon inspecting the boilers it was found that the boiler cleaner had driven wooden plugs in the steam outlets to keep the hot water and steam from scalding him. After the plugs were removed the boilers were put into service and were satisfactory.

I have found large boilers in paper mills with quarter sheets, single riveted, longitudinal seams 6 ft. long, and seams exposed to the heat of furnaces equipped with stokers. It is needless to say that these were replaced with new half sheets with longitudinal seams the same as in original constructions.

A certain manufacturer had ordered built 2 new boilers, 72 in. by 16 ft., to carry 100 lb. pressure. This was before the days of shop inspections. The boilers were shipped, set up, connected and ready for inspection. After being inspected and measured up, it was found that the boilers were only good for 83 lb. pressure, based on a factor of safety of 4. The cause of this was that the middle course of each boiler was built of 5/16-in. steel. This was reported to the manufacturer, who stated that we had made a mistake in our measurements. We then had his own men remeasure them and they could only make it 5/16-in. After this was gone over, the boiler foreman acknowledged that he had had the sheet laid out and put in, thinking that the inspector would just simply pass over it.

Great care should be taken not to let any oil get into the boilers, as I have seen new boilers with the tubes warped so badly that they had to be replaced, and then they would only last a few weeks. I have found cases where fireman and engineer have lost their lives just on account of boilers containing oil. Fire sheets have sprung so that they had to be removed, and corrugated furnaces collapsed.

In making an inspection for the Supreme Court of United States, of a Scotch marine, dry back boiler, that had exploded on a dredge boat, I found that the furnace had given way near the lap seam, which was located on the left side near the bottom. Built to carry 100 lb. pressure, the boiler was about 14 mo. old, and although the shell and tube sheets were badly distorted as evidence of excessive pressure, it was practically free from scale and deposit. In looking around for the safety valve, there was found in its place a cast-iron plug. Upon inquiry it was learned that the fireman of the boat, who, by the way, was the only one left, had been running the boiler without any safety valve for 4 weeks previous to the explosion, because they had had some trouble with the safety valve and were using the iron plug until they could get a new safety valve. The steam gage was found to be defective; in fact it would not register at all, and the valve between the steam gage and the boiler was closed up with deposit. The grate bars and the bearing bars had been removed and the fire was being built directly on the furnace bottom, which caused over-heating and burning of the plate at this point. With the above combination it is no wonder that the boiler left the boat. The boiler was carried about 650 ft. and buried itself half way into a marsh. It had been reported as defective in construction, but

*From a paper presented at a meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers.

considering the report of the inspection, it is doubtful whether any boiler would have stood such treatment.

It is just such cases as this that produce the idea that inspections should be made at regular intervals, and by an experienced inspector, one who is reliable and conscientious, and possesses good judgment.

Thorough boiler inspections cannot be made unless the boiler is dry, empty and accessible in every part. A design which does not permit this should be condemned. More perfect inspections by effective methods must, however, be legally introduced and well enforced before the steam boiler explosion can become extinct. There are about 1500 boiler explosions of varying intensities each year in this country, averaging from 400 to 600 persons killed, 700 to 800 persons injured, and besides this, damage amounting to many thousands of dollars is done.

In my opinion it is sufficient for anyone desiring to purchase a boiler plant, after having determined the working pressure and the size and type of units required, merely to specify that the boiler be built to the A. S. M. E. code. By so doing he will get from any reputable manufacturer a well constructed boiler entirely suited to its purpose.

I once made an investigation of an accident to a vertical "submerged" tubular boiler located in a sausage works. In talking to the man in charge, he said: "Well, I just filled the boiler full of water, put on a good supply of coal, and went over across the street to get a lunch, and when I came back the boiler was gone." The trouble was that he did not fill the boiler full of water, but did fill the furnace full of coal, and in place of getting a lunch he got drunk, and while he was gone the boiler exploded. It went up through the roof and buried itself in a neighboring garden.

Globe valves in the water columns should never be allowed, as I have seen new boilers explode due to the steam valve on the steam line being closed. Connections to water columns should be carefully attached, as boilers are sometimes completely destroyed, due to improper connections. I have found new boilers being operated for some time without any safety valves or water columns, but of course that was some years ago. Thanks to our new laws and codes these things are of the past.

If engineers are going to aid in the furthering of the "Safety First" movement, they can do nothing better about the plant than properly construct and valve the main steam lines, as elimination of accidents here will be of much benefit in safeguarding life and property against escaping steam.

Threaded Joints for Ammonia Lines

Use of Litharge, Solder, Care and Muscle to Insure Tightness

FOUR types are most commonly in use: The first, made with rubber packing, may be regarded as only a temporary expedient, to be replaced as soon as possible by one of the more durable forms.

To be satisfactorily tight over a long period, a threaded joint must be made up iron to iron, the "dope," whatever it may be, serving only as a filling between threads and for imperfections.

For such filling, litharge or purified red lead mixed with glycerine is frequently used. The litharge should be yellowish in color and fresh, and should be kept from exposure to the air. Unrefined glycerine is best, but the refined will serve if it is unmedicated.

The mixture sets quickly, hence only enough for one joint should be mixed at a time, to consistency such that it will enter between threads, but stiff enough to stand up and bank against the inner end of the thread. In using, fill the V of the thread level with the top; more is of no value. The joint should be screwed home to bring the pipe and fitting into metal contact throughout the joint.

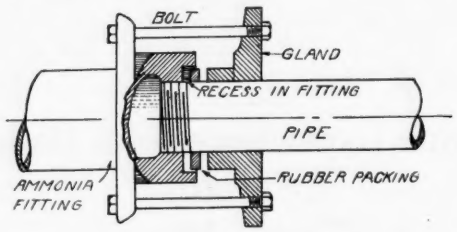


FIG. 1. A PACKED AMMONIA JOINT

Another form of filling is solder, used as a sweated joint, but it requires careful handling. The thread on the pipe is first well tinned, all excess solder being wiped out of the threads. Muriatic acid, in which all the zinc it will take up has been dissolved makes the best soldering fluid for tinning the thread. A pot of solder, large enough to cover the fittings is then melted and heated to such a temperature that a soft pine stick dipped into it will just char. Overheating makes the solder brittle and likely to break loose from the metal when cooling.

The fitting is next dropped into the molten solder and allowed to remain until it will float, which shows

FIG. 2. A PERFECT LITHARGE JOINT IN SECTION

that it is the same temperature as the solder. The joint is then screwed home while hot, before the solder hardens, leaving a film of solder which adheres to pipe and fitting; while screwing home, especially during the last few turns, one man must hammer the fitting hard, while another turns the pipe, so as to force all solder possible from between the surfaces. During the last turn or two the fitting will jump and "squall," but it must be pulled up as long as it can be moved, so as to bring the joint down firm, iron to iron, or a defective joint will result. The work must be done quickly, so as to complete the job before the solder sets.

After screwing home, the pipe is immediately stood on end, and the recess in the fitting filled with melted solder from a ladle before pipe and fitting cool. If properly made, this joint is hard to improve upon, but it is, of course, expensive.

As a variation of this, is the outside soldered joint used by the Vilter Mfg. Co. To be successful, the thread should be larger than usual, so that the fitting will not screw on by hand over 2 or 3 turns, yet long enough so that 3 threads will remain outside the fitting when it has been screwed home so hard as to round the fitting and pipe up true to each other and take out all stretch.

Before making up file or grind away all scale from the pipe for a distance of 0.5 in. back from the thread. Also scrape the recess in the fitting down to bright iron, removing all scale and rust. Wipe both threads dry and clean, making sure that all dirt, oil and grease are removed before making up the joint.

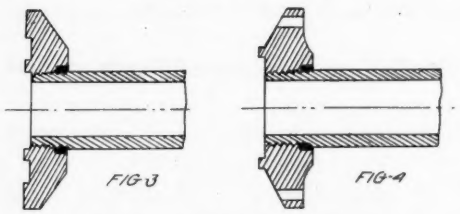


FIG. 3. THE SWEATED JOINT
FIG. 4. JOINT WITH OUTSIDE SOLDERING

After screwing home tight, and then tighter, and then a little more, end up the pipe, and heat the joint with a blow torch, keeping the flame for the most part against the fitting to expand it so that solder can work down. When heated so that solder placed in the recess, but not touched by the flame, will melt, pour the recess full of melted solder, and continue to heat the fitting for a short time. Set away, and allow joint to cool slowly. Do not use wet waste or a plunge in water to cool, as this will break the solder away from the surfaces.

Any one of these joints, if properly made, will prove tight and durable, but skimping on care or labor will result in leaks, either at first or after a short period of use.

The data is taken largely from an article by J. C. Calhoun in Refrigeration.

Metric Compulsion

ADVOCATES of legislation to make the use of the Metric System compulsory in the United States are eager for its adoption because they believe that a great saving will be made in computation, and that the interrelation of units will be of advantage. For purely scientific and laboratory work, there are advantages, but for practical use in trade, manufacturing and construction, there are difficulties and disadvantages that cannot be lightly disregarded.

Units in a decimal subdivision are not natural or convenient, as is proved by the universal use of halves and quarters of units such as the yard, mile, pound, ton, gallon, etc. It is easy to divide and to estimate, halves, quarters and thirds, but fifths or tenths are not easily handled, except by repeated trials.

In a bulletin issued by the American Institute of Weights and Measures, detailed consideration is given to six of the main arguments of the metric advocates, the substance of the replies being as follows:

Universal use of the metric units except in the United States, Great Britain and Russia does not seem to accord with the facts that even in countries where compulsory laws have been passed penalizing the use of other than metric units, the old units persist in everyday trading and measuring. This is true in most of Spanish America, even in France, where the system originated. And when the use is permissive or is adopted for official use by the government, the greater part of the business of the countries is still done with the old units, which the people find more convenient than the new ones.

That the adoption of the metric system is easy and the transition period short is discredited by conditions in Europe. After 112 yr. of effort and 70 yr. of compulsory law, France finds that in the textile industry, where it would seem that the change would be comparatively easy, the old weights and measures are used in advertisements and catalogs for practically all articles; and merchants claim that if they change to comply with the law, the result will be serious loss of business. Equivalent metric sizes are marked on the tickets, but the people cling to the "aune" and the inch. And in Germany, the yard and pound are frequent, even the old "ell" being common in woolen industries.

Confusion of units does not seem so marked among English speaking peoples as is sometimes claimed. The English inch is standard in manufacturing over a greater part of the world than any other unit. The pound is the standard of weight for everything but drugs; the long and short ton are the only confusing units, and metric tons will simply add a third unit instead of abolishing one. Wet and dry measures should be harmonized, preferably by doing away with one set of units as Great Britain has already done. But adding the liter will not simplify matters. In fact, in South America the inconvenience of the jump from the liter to the dekaliter has resulted in the adoption of a metric gallon of 4 liters, which is neither one system nor another, but simply illustrates the lack of adaptability of decimal division of units to ordinary trade.

So far as reduction from one unit to another is concerned, the advantage in practical use is not so great as those whose work is largely calculation seem to think. In general, for each class of commodity the measurement is made in the unit best suited to the purpose and such fractions of that unit as found most convenient, either tenths, halves, quarters or eighths. Groceries are sold by the pound, coal by the ton, cloth by the yard, water by the cubic foot. Seldom is there occasion to transform from one unit to another, except in the matter of money and time, and in these units the metric advocates propose no change. Shop measurements are almost entirely in inches, the foot having nearly disappeared. This has come about by practical elimination to get the most convenient unit for shop purposes, and gives as great simplicity and accuracy as could be had by the use of any metric unit. Saving in time of calculations becomes, therefore, somewhat mythical, particularly in the time of school children; for examination of the schedule for the New York schools shows that the total time devoted to arithmetic in 8 yr. is from 7.8 to 12.2 mo., and that portion given to denominate numbers is 2.2 to 3.35 weeks. If all study of units,

except the metric, were eliminated, the maximum saving to the child would not be greater than these figures, and part of this saving would be offset by the increased time spent on metric units.

Importance to foreign trade does not seem to bear analysis. France, Germany, Russia, buy United States tools, made to English measurements with no inconvenience; in fact, Lawrence V. Benét, engineer of Hotchkiss & Cie, makers of munitions, states that he knows no case where building to English measurements has affected the sale of American tools in France, and all the newer establishments have a large number of such tools. We buy freely of metric countries, never asking to what system of units the goods are made. Some information as to performance may well be stated in the units of the country to which machines or goods are sold, but this is simply the equivalent of printing a catalog in the language of the country to which it is sent. It does not require the overturning of a system of units which, on the whole, has proved the most convenient for daily use of any yet devised.

Liberty Loan Bonds

FREE-TAX OBLIGATIONS OF THE UNITED STATES SECURED BY THE ENTIRE RESOURCES OF THE NATION, BEARING 3½ PER CENT INTEREST PAYABLE SEMI-ANNUALLY. A GILT-EDGED INVESTMENT AND A PATRIOTIC SERVICE.

THESE bonds, of which $2,000,000,000 are to bear the date of June 15, 1917, and run for 30 yr., unless paid by the government at the end of 15 yr., are a mortgage on the entire resources of the country, hence have the best security of any investment that can be made.

They bear 3½ per cent interest annually, payable at any bank on June 15 and Dec. 15. of each year, and the bonds and income are free of all taxes by city, county, state or nation, except inheritance tax, hence the net return is as high as can be secured from corporation bonds which carry a higher interest rate from which taxes must be paid.

Two classes are to be issued—those payable to bearer in denominations of $50, $100, $500 and $1,000—and registered bonds for $100, $500, $1,000 and larger amounts. The "bearer" bonds will have coupons attached which can be cashed at any bank; the registered bonds will have interest paid direct by the Treasury Department to the registered owners.

Application for bonds may be made to any bank or bond-selling house, payment being made either in full with application or of 2 per cent of the value applied for with the application and the balance when the bonds are issued. Most banks are arranging to receive payments in monthly installments if so desired, and to deliver the bonds to owners when payment has been completed.

These bonds are to furnish the means of carrying on the war for freeing the peoples of the world from domination by autocracies, hence the name "Liberty Loan of 1917," and are the loan of a free people to help in freeing all people from future wrong and aggression. It is desirable, therefore, that everybody should have a part in making the loan, which will assist in this great work as well as provide a safe and remunerative investment of funds.

If the money invested is needed for an emergency, any bank will be willing to accept the bonds for re-sale, so that the money is not tied up beyond recall.

The small denominations make it possible for all to subscribe, particularly with the partial payment plan. Subscriptions for small amounts will be given preference in making allotment over large subscriptions, so that the small investor will be practically certain of getting the bonds he wants.

All of us want to stand by our country in this crisis. Because of age, families and other preventing reasons, not all can take personal part in the war activity, but all can have active part in the Liberty Loan and thus contribute to the success of this war for freedom.

Application forms can be had from any bank, postmaster or express office. Our nation will be judged by the number who take part in the loan more than by the amount which each one buys. It's up to all of us to prove that we are Americans, that we love and believe in Our Country and mean to do our "bit" promptly.

Cooling by Compressed Air in Paris

IN A RECENT ADDRESS to the graduating class of a technical school in Washington, D. C., Alexander Graham Bell described an interesting compressed air plant operated by the "Societé de l' Air Comprimé" in Paris, France.

Many of the Parisian cafes and restaurants have cold rooms for the storage of perishable provisions, which are cooled by compressed air supplied by this company. At the central station, steam engines are employed to drive compressors which maintain a steady pressure of from 4 to 5 atmospheres, distribution being accomplished by large mains in the streets and branches extending to the cafes and restaurants. As there are several hundred kilometers of these pipes under the streets of Paris, they form a huge reservoir of compressed air at the ground temperature.

In the cooling room of the cafe, the opening of a cock admits the compressed air which in expanding produces the desired cooling effect, this cooling being increased by allowing the air to do work during the process of expansion. Dumb-waiters, elevators and even sewing machines are thus operated by means of compressed-air engines. A gas meter measures the amount of air admitted and charges are made accordingly.

BUREAU OF MINES announces the following among its new publications, only a limited supply being available for free distribution: Technical Paper 137, Combustion in the fuel bed of hand-fired furnaces, by Henry Kreisinger, F. K. Ovitz, and C. E. Augustine, 1916; 76 pp. Technical Paper 138, Suggested safety rules for installing and using electrical equipment in bituminous coal mines, by H. H. Clark and C. M. Means, 1916; 29 pp. Technical Paper 164, Accidents at metallurgical works in the United States during the calendar year 1915, compiled by A. H. Fay, 1916; 20 pp. Miners' Circular 23, Elementary first aid for the miner, by W. A. Lynott and D. Harrington, 1916; 23 pp.

Requests for all papers cannot be granted. Publications should be ordered by number and title and applications addressed to the Director of the Bureau of Mines, Washington, D. C.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Equalizing Load on an Engine

AFTER the valves of a releasing gear engine have been set by the marks provided by the builder, the governor is usually adjusted to give equal cutoff for each end of the cylinder by blocking it up to the average running position and so adjusting the knockoff rods that the steam valves are released when the crosshead has traveled an equal distance from each end of the stroke measured on the guides.

When the indicator is put on and cards are taken, it is often revealed that one of the steam valves should have more or less lead to give the best results. The engineer proceeds to change the length of the steam radial rod as his judgment dictates, then the valve motion is moved into the extreme throw to be sure the clearance for the hooks is ample, and if not, then the dashpot rod is changed to make it so. If, at this point, the engineer should start the engine and with average load he would find the cutoff uneven, should he block the governor in the running position and bar the engine over, measuring the distance the crosshead traveled up to cutoff from each end, it would confirm what he learned from the cards, and the reason therefor is this:

For any governor position, the position of the knockoff cam is fixed and when the gear was originally adjusted the hook came into contact with the knockoff cam at a certain point in the piston stroke. Now, when the length of the steam radial rod was changed to alter the steam lead, the relative position in the piston stroke between steam hook and knockoff cam was also changed. If the card showed the lead to be late and the steam radial rod was shortened, it would cause the tail of the hook to engage the knockoff cam earlier in the piston stroke because the position of the knockoff cam remained unchanged so that the shortening of rod brought the hook nearer to the cam, with the valve motion in central position. This same relation holds for any other position; result, that the piston does not travel as far before the two engage and the valve is released.

Some men, in adjusting for equal cutoff, carefully measure the distance from each admission line to cutoff and juggle the knockoff rods until they are equal in length and consider the engine in the best condition for good work.

The writer always sets the cutoffs so that the total load on the engine is equally divided between the 2 ends of the cylinder, and disregards the length of cutoff on each end to bring this result.

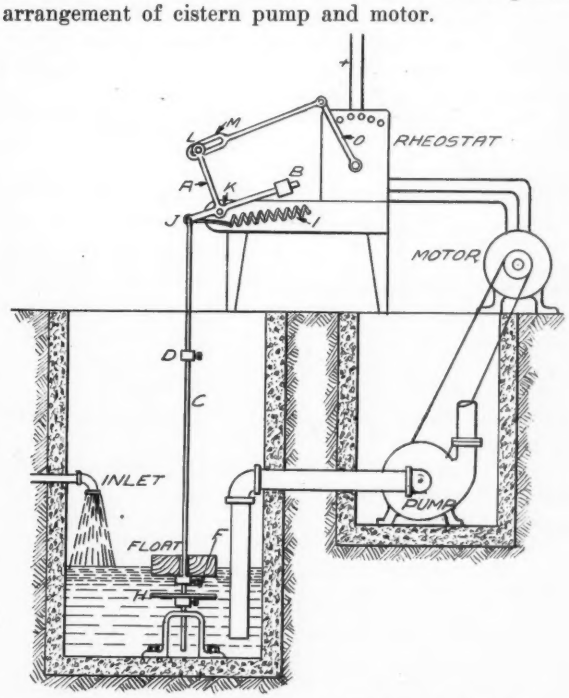
When an equal amount of work is done in each end of the cylinder, better regulation is obtained, the power is developed with a smaller steam consumption and the engine usually runs quieter.

To divide the load equally between the 2 ends of the cylinder, the length of cutoff will generally be found to be longer on one end, because the valves and piston often leak, and to make up for the loss of piston area on the crank end, due to the piston rod, unless a tail rod is used. The writer always so sets the cutoffs that the two cards, one from each end of the cylinder, show equal areas, or m. e. p.'s.

RECEIVER.

Automatic Sump Pump

PROBLEM: To start and stop automatically a motor-driven centrifugal pump to keep the cooling water from a number of internal combustion engines from overflowing cistern and to deliver it to the sprinkler heads above the roof to cool. The sketch shows the general arrangement of cistern pump and motor.



ARRANGEMENT OF CISTERN, PUMP AND MOTOR

The starting box or rheostat for the motor was placed upon a bench as shown and so wired that the first contact cut in the field circuit and the remaining controlled the resistance. To the bench was pivoted the bell crank, A, carrying a counter weight, B, which balanced the weight of the pipe, C, and its collars, D and F, and the steel disk, H. As the water fills the cistern, the float rises, striking the stop, D, and slowly raises the pipe, C, collars and steel disk, H, stretching the spring, I, until the pin, J, is above the pivot, K, when the pin, L, is at the bottom of the slot in M, permitting the spring to

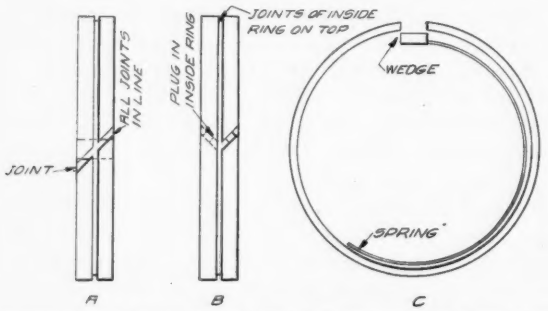
pull contact lever O as fast as disk H will move through the water, starting the motor and pump slowly. When water is pumped out until the float rests on F, mechanism will take the position shown quickly, as disk H will not retard the movement of pipe C. C. E. SARGENT.

A Unique Pump-Repair Job

HAVING HAD considerable trouble with my boiler-feed pump in that it would drag and the steam would blow through to such an extent as to necessitate using the injector to help it out, I decided to open the pump and determine the exact cause of the trouble.

I found that the cylinder had been rebored, leaving the follower ¼ in. too small and the snap rings so placed that their joints and that of the bull ring were in a direct line as shown at A in the accompanying sketch. This, of course, was the cause.

Removing the piston, I shifted the snap rings as at B, leaving the bull-ring joint on top and bringing those



SHIFTING THE SNAP RINGS AND EXPANDING THE BULL RING PREVENTED FURTHER LEAKAGE

of the snap rings down to the sides, but 180 deg. apart or opposite one another.

The snap rings were held in place by small plugs driven into dovetail slots cut on opposite sides of the bull ring, which was then expanded sufficiently to produce a working fit between the snap rings and the interior of the cylinder by means of a wedge and spring, as at C.

The pump was then put together and started up, and not only did it work like a new machine, but it has operated satisfactorily ever since, which is now 4 yr.

PHILLIP J. COX.

Fuel Economy

TODAY we hear of the central station getting in and it is taking many plants; some engineers deserve to lose to central station, many do not. Being only an amateur in engineering, I will not attempt to tell the old heads or young ones either how to do it, but I will try to tell what I have done and intend to do. I had charge of a 72-in. by 18 ft. boiler while the old engineer was sick. I found part of 2 upper rows of tubes exposed on account of failure of the arch, the back wall was nearly down, allowing the arch to settle. As soot covered everything, these tubes were not noticed. The clean-out door was cracked, being held up with baling wire. There was a hole about 8 by 2-in. in the side wall where the blowoff came through about 8 by 12-in. After repairing these and closing numerous bad cracks in the setting, the boiler steamed better.

This neglect of boilers and settings of furnaces, grates, combustion chamber, in fact the entire boiler plant, is one big thing that the central station uses in advancing its arguments.

I carried another plant on one boiler, a Stirling, while No. 2 was down for cleaning and they said it couldn't be done. It was, and easily, after I got that boiler clean, and I mean clean inside and out. Don't be afraid to get down inside the passes of your Stirling boilers; you can easily climb up again and you may find something to interest you down there, provided you are interested in fuel economy.

A great many plants I've seen using Stirling boilers do not blow tubes, depending on gravity, I guess, to let soot fall off. Here is one place where gravity will fall down on the job. I have the drums scraped clean outside, and all ash removed from top of bottom drum; if neglected, you will find a lot there.

Bottom drum is also scraped clean and all soot and ashes thoroughly cleaned out of setting whenever a boiler is down. My idea is a clean boiler inside and out.

Then stop the air leaks; take a draft gage, a plain U tube (2 gage glasses connected by a hose will do), fasten them on a board and from 1 glass run a length of hose, put end of hose to some cracks you find, also clean-out door and door at base of stack; you will find some things to interest you. J. C. LEE.

He Never Saw the Article

BIG ED SMITH believed thoroughly in taking and reading an engineering paper. He admitted that he learned much in the paper he subscribed for. It was of great assistance to him in operating his small power plant.

There was one thing, though, that Big Ed always had trouble with, and that was his flues. He couldn't keep them tight. They leaked to beat the band. He looked through the papers carefully every issue, the flue matter being always uppermost in his mind, but never a thing did he find that helped him on that subject. He bettered his fuel economy in a number of ways; he kept the place looking neater; he earned several raises in salary and got them; but he was never satisfied with his flues.

One spring morning his fireman didn't show up, and so Big Ed tried to handle the whole job alone. He succeeded to the extent that he kept things going, and during the illness of the fireman managed to get a person who filled the same amount of space as a man, but you could hardly call him a fireman. This person tried to shovel coal into the furnace. His principal success was he made the flues leakier. And Big Ed's time was taken up more than ever. He became so busy that he didn't have time to read his paper.

When the smoke cleared away and the regular fireman came back and things got to running as smoothly as before, in came a new copy of the paper and mechanically Big Ed put the old one away, saying to himself, "I am too busy to read that one. I'll pass it up." He went back to his flues and tried a new way to make them tight.

The point is this—in the very issue that Big Ed didn't look at was an article entitled, "Keeping Flues Tight." It would have done him a world of good. He

never saw it; he was kept so busy with his flues that he never had time to review his papers.

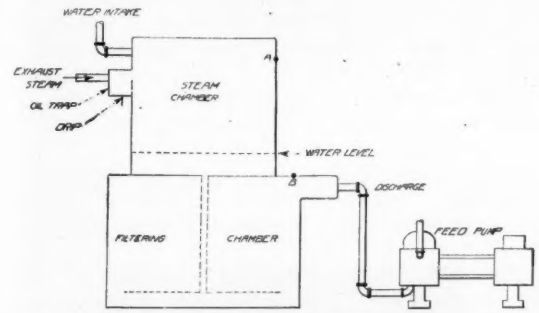
Having heard Big Ed's story, and having had similar experiences myself, I have resolved never to miss a single issue in the future. N. G. NEAR.

(Big Ed should have read that paper, we all agree, but if any subscriber of Practical Engineer needs such information it can be had by writing to the editorial department explaining the difficulty.—Editor.)

Overcoming Steam Binding

IN A combined pumping and heating plant, with vacuum return system, trouble was experienced with the feed pump becoming steam bound frequently.

The pump took its water from a heater, shown diagrammatically in the accompanying figure, in which the water level was 3 ft. above the pump.



HEATER WHICH GAVE TROUBLE FROM STEAM BINDING

As the load was quite variable, the trouble was thought to be caused by frequent changing of the steam pressure in the heater. A ½-in. bypass between the points A and B made an effective solution to the trouble.

J. M. ROW.

A Feed Water Experience

IN THE case of a badly scaled boiler that came to my attention the tubes were all clogged and the only openings for circulation were at the sides and down through the center between the center rows of tubes in a horizontal return tubular boiler. The shell was scaled in some places more than an inch thick; the bottom shell plates and tubes on the rear head were all badly burned; the shell had to have a 24-in. patch put in the girth seam over the fire, and new rivets put in each of the 3 girth seams, and the seams all calked and new tubes put in.

The feed water was vegetable water taken from a brook, and analysis showed it to be very good, hence the mystery in the scaling of the boiler. The returns from the heating system had all been used over in the boiler, and the steam from the pumps and engines was all turned into the heating system. I doubt if there is any reader of this paper who could not see at once the real cause of the trouble.

The returns all came back to a large tank from which the water was pumped through a closed heater into the boiler, enough fresh water from the brook being added to make up the loss. There was no surface blowoff on the boiler; the bottom blowoff was seldom used except for emptying the boiler; and the compound used was only used at times, apparently only when a boiler was found to be entirely stopped up with scale. This did not seem to remove it and information was sought.

Solvents of all kinds had been recommended, but the scaling hammers and scrapers were the first effective remedy applied; then sal soda in small quantities was used and the scale removed with the above mentioned results of damages.

It was further discovered that the compounds had been pumped into the boiler by putting the pail under a pipe connected to the suction pipe of the pump and closing the stop valve in the suction line until all the compound had been pumped into the boiler, then opening the stop valve on the suction line to the tank again. Opening up the tank showed much grease deposit along the water line and the tank was a mass of greasy mud, which was removed, and the tank was cleaned at regular intervals thereafter. The oil used in the cylinders of the pumps and engines was such that after passing with the steam through the heating systems it would become thoroughly mixed with the return water and settle to the bottom of the tank, adhering to the plates in a thick paste-like substance, much of which was pumped into the boilers where it was baked hard with the heat.

The grease separator had never been cleaned and was not in working order; the oil had passed through the entire heating system and was coming back in large quantities.

The pump exhaust pipes were separated from the heating system, as the pumps used too much oil to take further chance in using the steam for heating purposes. It required most strenuous efforts for several weeks to get the oil out of the heating system and keep it out of the boilers. Had there been an open heater with an overflow chamber to allow a portion of the water to escape, no doubt it would have carried off considerable of the oil before it had been pumped into the boiler. Then, too, the filtering system in the bottom of most open-type heaters would have collected immense quantities of this paste-like grease and added much to keep the boilers clean.

It is almost impossible to keep these dissolved impurities out of the boiler unless the surface blowoff and also the bottom blowoffs are regularly used to draw off the impurities and scale-forming mud as soon as they are neutralized and keep its density at such a stage that it will not crystallize into a hard scale.

Scale is always caused from deposits which are left in the boilers after the water has been evaporated into steam, and are always introduced with the feed water; but much of these impurities get into the water after it has left its source of supply, either in the form of grease, excessive use of compounds, or corrosion from old piping and apparatus in the entire system of the plant. Had the soda been put into the tank, no doubt the tank would have collected more sediment and, if emptied and washed out regularly, would have removed much of the scale-forming impurities from the water before it entered the boiler. R. A. CULTRA.

THE ENGINEERING FOUNDATION, which is administered under the auspices of the United Engineering Society and the national Societies of Civil, Mining, Mechanical and Electrical Engineers has placed its funds at the disposal of the National Research Council for organization and operation expenses.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Temporary Repair of Pump Rod

THE BREAKING OFF of the threaded end of a pump rod, water end of pump, used for boiler feed, would have necessitated putting the pump out of service until a new rod could have been obtained, but for a temporary repair.

Figure 1 shows that the end of the pump rod was broken off even with the piston, which proved to be the result of an old flaw in the metal. It is shown in Fig. 2 how the tapered end of the rod was cut away and another piece of metal, of the same composition as that of which the rod was made, fitted into its place. This piece was long enough to accommodate the threads for the nuts which hold the piston and follower in place. Figure 3 shows the parts assembled, the key driven into place and the piston put on.

The strength of the rod now depends upon the thickness of the metal at A in Fig. 2, or the shearing strength

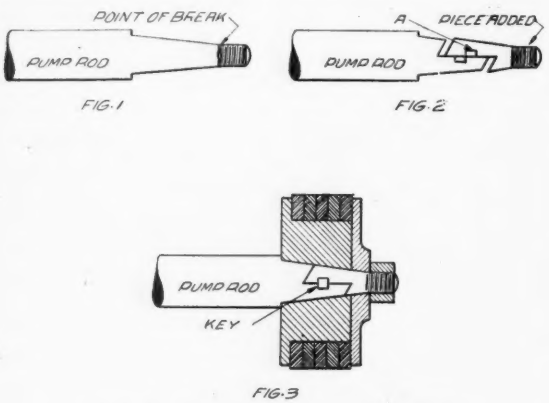


FIG. 1. PUMP ROD SHOWING BREAK
FIG. 2. ROD SHOWING METHOD OF REPAIR
FIG. 3. REPAIRED ROD AND PISTON ASSEMBLED

of the key. It is plainly seen by referring to the figure that the key must be sheared through its greatest dimensions, therefore it need not be very large, which will give greater strength to the metal at A, Fig. 2. The key should be of a tough metal and made to a loose driving fit.

The end of the rod is tapered, therefore the part added should be trued up to the same taper and made a snug fit into the piston so as to hold the repaired parts more firmly together, thereby increasing the strength of the rod at that point.

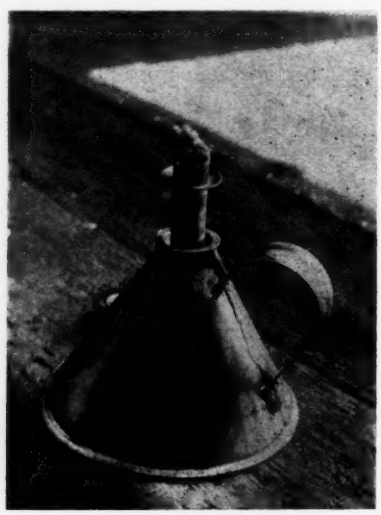
The repair can be made permanent instead of temporary by brazing, if the proper kind of spelter is at hand and the use of a blacksmith's forge is to be had. Spelter and a forge are not always to be found in the average plant of ordinary capacity; but an old pump rod, which has been consigned to the junk pile, a hacksaw and file are always to be found, therefore a temporary repair can be made pending the receipt of a new rod.

The pump on which the above described repair was made has since been in operation for some time and has given entire satisfaction. W. M. C.

Safety Tip for Kerosene Hand Torch

THE KEROSENE hand torch necessarily used in a good many instances, is the cause of not a few accidents. Due to the heat at the tip, the oil sometimes follows the wick a little faster than it can be burned, more especially if it is necessary to hold the torch in an inclined or tipped position, and running free, soon fires the entire torch.

The photograph shows how a ring can be applied to the tube a little below the wick opening. If held in a horizontal position, the oil cannot run down over



TORCH FITTED WITH SAFETY TIP

the tube but drops off free of the torch. If a little does collect in the disk, it is fired up where it will cause no trouble. This difficulty is, of course, always experienced with the kerosene torch because it is not practical to thread the tube too tight with the wicking, which causes a poor flame and light to be given. The little ring is easily secured to the tube, and is a sure safeguard against an explosion caused by the running oil.

F. W. BENTLEY, JR.

Replacing a Crankpin

THE CRANKPIN in our engine became loose, so, securing a machinist, we proceeded to put in a new one. We took the old pin out and got things in shape by the time the new pin was done, then we heated the disk

until the machinist said it was O.K. I corralled the superintendent (who is a 200 pounder), and told him to keep the business end of a 20-lb. sledge working on a block of wood held against the end of the crankpin. He smacked it a few times; when it got within an inch of home, it stopped and stayed stopped, for the machinist had missed the heat.

It was up to us to move her and move her we did, proceeding as follows: We drilled a ¾-in. hole clear through the pin, tapped the rear end of the pin for ½-in. pipe, heated disk and pin hot, took a good strain on the end of the pin with a ratchet jack, got water going through the pin by means of pipe and hole we drilled. When water had been turned on about 2 sec., the pin began to move.

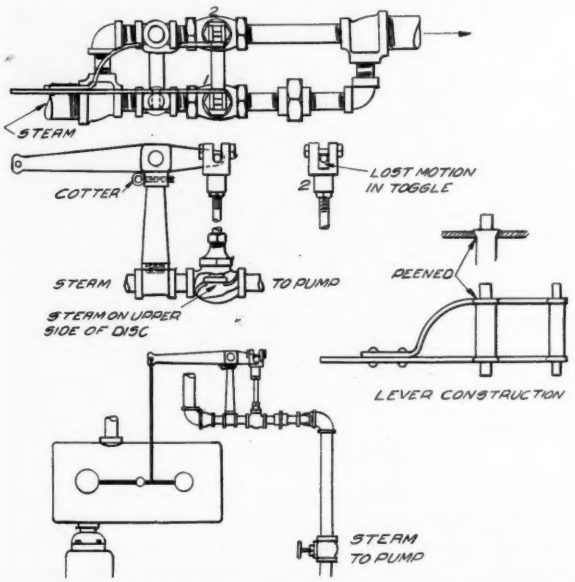
By keeping a good strain on the pin with the jack and tapping back of disk, we got the pin clear home, and the boss smiled, for we had been down 3 days. By plugging the back end of the pin, it did not affect the oiling in any way. The pin is a good fit and has not given us a moment's trouble.

While this is not a new stunt, it may get someone out of a hole, as it did us, so I am passing it along.

H. M. O.

Float Controlled Valves for Regulating Pump

We experienced trouble with the balanced piston float controlled valve of our return pump, which would leak enough to keep the pump in motion even when the water was all pumped out of the tank, and caused more or less damage to the pump.



DETAILS OF PIPING AND ARRANGEMENT OF VALVES FOR AUTOMATICALLY CONTROLLING PUMP

Our remedy was to make a new valve composed of pipe fittings and two Jenkins valves with threads turned off stems.

The action is as follows: Steam comes in on the top side of the disc. When the lever is depressed, valve 1 is opened.

If steam enough is admitted through valve 1 to run the pump, valve 2 remains closed; but if more steam is needed, the lever is further depressed (by float) and valve 2 opens. Steam closes valve 2 first.

This action saves the seats. Discs can be renewed in 15 min. and require renewing only twice a year.

The pump stops dead now when the float drops.

C. J. Wilder.

Thawing Frozen Air Line; Foundation Bolt Kink

Water in a compressed air line gave trouble by freezing in an exposed part. It was thawed out and kept open during extreme weather by means of the device shown in Fig. 1. A piece of discarded sheet-iron roofing was bent to form a V-shaped trough and suspended

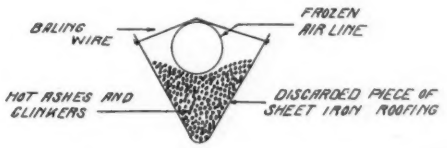


FIG. 1. DEVICE FOR THAWING FROZEN AIR LINES

under the pipe; hot ashes were supplied from the boilers and were renewed at intervals of about 1½ hr.

In moving machinery from one foundation to another it frequently happens that the measurements for the setting of the foundation bolts are taken hurriedly, under disadvantageous conditions or by an incompetent person;

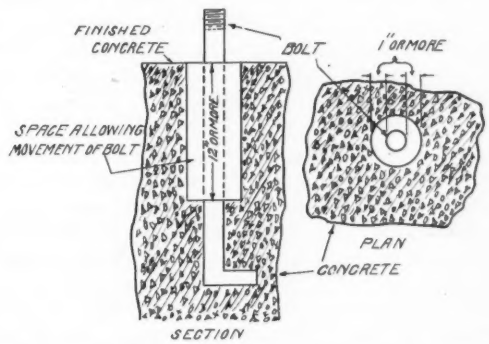


FIG. 2. CONVENIENT FOUNDATION BOLT ARRANGEMENT

or the bolts may be moved a little out of position when concreting. The idea illustrated in Fig. 2 will often take care of these unavoidable inaccuracies, and thereby save considerable time, money and inconvenience, at the same time being little trouble to use. Roy H. Poston.

U. S. Civil Service Commission announces an examination for aid in the Coast and Geodetic Survey, on June 6 and 7. Vacancies occurring in the positions of aid and deck officer in the Coast and Geodetic Survey and extra observer and draftsman on board ship will be filled from this examination. Competitors will be examined in mathematics, practical computations, surveying, astronomy, physics, topographic drawing and lettering, training and experience. Under the element of experience credit will be given for experience in accurate surveying, leveling, or computation work. Applicants must have reached their eighteenth but not their twenty-fifth birthday on the date of the examination. Apply for Form 1312.

Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

How Much Oil Do You Use?

ON PAGE 247 of the March 1 issue, we requested those of our readers in charge of reciprocating steam engines to send us a list of the engines in their plant, together with other information from which we might determine, for the benefit of all interested in the subject, the average amount of oil engines of various sizes and types, operating under given conditions, might require. The results of our findings we want to make available to the readers of Practical Engineer, who we are sure will find such information of much value.

We greatly appreciate the readiness with which a number of the engineers responded to our request, but find it necessary, in order to impart the results of our findings in as complete a form as possible, to ask more of the readers to come forward with the data they can furnish. Regardless of the kind or size of plant in which you are employed, if you are sufficiently acquainted with the details of operation, we would be pleased to have you send us a list of engines in the plant, the number of cylinders of each, their dimensions, the number of revolutions each engine makes per minute, and the quantity of oil fed each cylinder per hour or per run. If you give this in terms of the latter, be certain to apprise us of the number of hours which ordinarily constitute a run; and in addition, we would like to know the grade of oil used and whether this is mixed with graphite before being fed, the steam pressure, the condition of the steam, whether wet, dry or superheated, and the type of valves employed.

But little of your time will be required to prepare and send us this information and when compiled and available for your use, may be the means, either directly or indirectly, of reducing the consumption of cylinder oil in your plant.

Won't you cooperate with us for the benefit of all of the readers of Practical Engineer? EDITOR.

Storing Shelled Peanuts

WILL THOSE of Practical Engineer's readers who have had experience in the cold storage of shelled peanuts kindly give me some information as to how they may best be stored? How should they be packed and what temperature do you recommend maintaining?

J. I. Z.

What Is Your Opinion?

ON PAGE 365 of the April 15 issue, J. C. L. asks for an explanation of the blacking of the commutator bars on a compound generator.

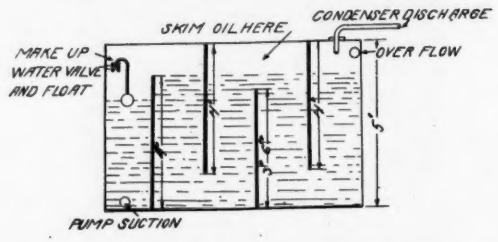
I would suggest that this is probably due to the fact that his machine is wound on the principle of the short cord winding, which results in a narrow neutral zone, and requires a very accurate adjustment of the brushes. It will probably be found that the spacing of the brushes is not even, and, therefore, that under each set of positive brushes there is a decided sparking; or it may be that the brushes themselves are too wide, short-circuiting too many of the commutator bars; or there is a possibility that the equalizer connections in the armature itself have loosened.

I should first test for the brushes, being properly located on the neutral point, by making a careful potential test of the commutator, and determine exact neutral point. If this does not clear up the difficulty, I should look for the trouble from too wide brushes; then look for loose equalizer connections in the armature.

HENRY D. JACKSON.

Eliminating Oil From Condensate

IN REFERENCE to the problem of W. V. appearing on page 402 of the May 1 issue, I would suggest that he reduce the amount of cylinder oil used in his engine, as he states that about 1 qt. of oil enters the boiler per day, and as 70 per cent of the total oil used is removed by his separator, it would appear that he is using about 3⅓ qt. per day in an engine having a daily steam consumption of 50,000 lb., or an hourly consumption of 50,000 ÷ 24, or 2083 lb. Assuming a consumption of 17



ARRANGING HOT WELL IN THIS MANNER SHOULD ALLOW READY REMOVAL OF OIL BY SKIMMING

lb. per hr. he would have 2083 ÷ 17, or about a 122-hp. engine, and it should be entirely possible to reduce the cylinder oil to 2 qt. per day with the occasional use of graphite. Then, by installing a large hot well with several compartments arranged so that the entering water may flow under the first dividing wall, over the second, under the third and over the fourth, a large percentage of the oil will collect on the surface of the second and third compartment, where it may be removed by skimming. (See sketch.) Then, by passing the feed water through a good grease extractor (a number of which are on the market and have proven satisfactory), the remaining amount of oil should be so small as to be of no importance, that is, not over 1 to 1.5 grains per gallon. I would, however, advise him to open the boiler, say every

two weeks, in order to determine the actual condition of the heating surface.

The two greatest objections to allowing oil to enter a boiler are: First, any acids a compounded oil may contain will attack the metal, causing pitting along the water line; second, oil being lighter than water, floats on the surface until it comes in contact with other suspended matter, with which it mixes and settles to the bottom or heating surface of the boiler, and, having an affinity for metal, it forms a nonconducting film on the plates which prevents a ready transfer of heat from the plates to the water, thus causing the temperature of the plates to increase, which may lead to bagging and complete rupture of the overheated portion.

Cylinder oil recovered from separators is often used by mixing with graphite or grease, to lubricate pump plungers, line shafts, etc., but I doubt whether it would be of much value for reuse in the engine cylinder.

A. C. McHugh.

There is little to say to W. V. in reference to feeding oily water to his boilers. Do not do it! If it were possible to keep the oil from portions of the boiler where the furnace heat acts directly upon the iron, there would be little or no harm done; but, unfortunately, oil has a bad habit of adhering to everything in the way of scale-making material and sinking with the scale to the bottom of the boiler and soon making a waterproof paste on the iron over the fire. A bulge results or the tubes will be burned and leak at the ends.

One quart of oil in the right place would put any boiler out of service the same day; but, fortunately, most of the oil going into boilers floats on top of the water and is carried out by the steam. W. V.'s own observation of the internal condition of his boilers will tell him better than anyone can, how often to open them. I have heard of cylinder oil, after being retrieved from the exhaust steam separator, being used in cylinders again; but, understand, I have only heard of its being so used. I would advise limiting its use to freight elevator guides, or better yet, present it to some enemy to lubricate his "flivver." C. E. C.

Examination Questions from Massachusetts

The answer given by W. E. Aldrich to question 2 on page 283 of the March 15 issue, is not looked favorably upon by the writer for, while the speed can be

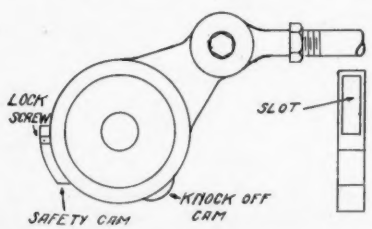


FIG. 1. MANNER IN WHICH SAFETY CAMS WERE ATTACHED IN EARLY TYPES OF CORLISS ENGINES

changed by the method described, I believe better methods may be employed.

In many of the older engines, the safety cam which causes the hook to release the steam valves before the steam ports are opened when the governor is in the highest or the lowest position were secured to the circumference of the knock off cam by a screw which fitted inside a slot cut in the safety cam and was tapped into the knockoff cam, as shown in Fig. 1.

Should an attempt be made to change the engine speed when running by changing the lengths of the knockoff rods, as Mr. Aldrich states, I have known of cases where the safety cams would be useless as far as their value to prevent a runaway engine is concerned, because they would have been moved into such a position in relation to the steam hooks that they would not hold the hooks down when the governor was in either ex-

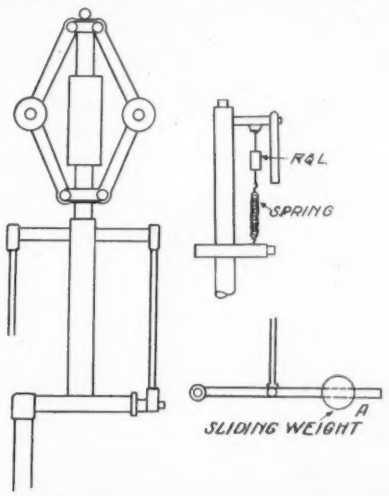


FIG. 2. SLIDING WEIGHTS OR SPRINGS ARE PROVIDED FOR SMALL CHANGES IN SPEED

treme position and of course this is recognized as a dangerous condition.

Whenever the lengths of the knockoff rods are changed the only safe way to proceed is to place the governor in its highest and lowest positions and so locate the safety cams that they will prevent the opening of the steam ports and due care taken in tightening them so that they may be depended upon to stay where placed, and their locking device gone over frequently to be sure they remain where they belong.

Modern engines usually are so designed that the safety cam is integral with the knockoff cam which is

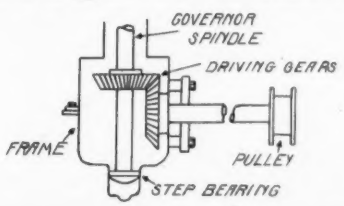


FIG. 3. RATIO BETWEEN SHAFT SPEED AND GOVERNOR SPEED IS DEPENDENT UPON THE RATIO BETWEEN THE NUMBER OF TEETH ON THE GEARS

a far better arrangement than that mentioned for the older designs.

Most governors are fitted with a lever with sliding weight, as shown in Fig. 2 at A, or a spring is provided to secure a change of speed from a fraction of revolution

up to 2 or 3 revolutions and in many kinds of service is a necessity if anything like uniformity of speed is to be maintained.

When it is necessary to make a radical change in the speed of an engine with releasing gear that is 5 or more revolutions per minute, the better way is to change the diameter of the pulley that drives the governor, care being taken to maintain the original speed of the governor as better regulation is obtained. The proper way to change the speed of an engine is as explained by Tom Jones on page 366 of the April 15 issue.

One may say that if we want to find the speed of the governor before any change is made, we can calculate it from the diameters of the pulleys that drive it and the speed of the crank shaft; but this is not always possible, for many engines have the speed of the governor 2 or more times that of the crank shaft when originally built, and obtain this high speed by providing gears of different diameters to drive the governors, as shown in Fig. 3. Therefore, the number of teeth in these gears must be taken into account when figuring the governor speed, or what is usually easier, as one does not have to strip the engine when these gears are enclosed, is to take a speed indicator and insert the spindle into the center in the top of the governor spindle and obtain the speed. RECEIVER.

I READ with interest the Massachusetts examination questions and answers as published on pages 283 and 284 of the March 15 issue, and also the criticisms of those answers published on pages 366 and 367 of the April 15 issue. There are, however, two points on which I am not fully in accord with the views presented.

Tom Jones, in answer to the question, "Steam pressure and speed remaining the same, how would you make a Corliss engine develop more power?" explains his idea of changing the governor rods. I should answer this question in just 3 words—"Add more load." We know that under the terms stated in the question, the steam pressure and speed are to remain the same, and that the only way that remains to develop more power is to increase the mean effective pressure by causing later cutoff. The governor of the Corliss engine is of such design that should we attempt to change the governor rods to get later cutoff, the speed would momentarily increase and the governor would assume a higher plane, bringing the point of cutoff back to the original point with a given load, maintaining the same speed and mean effective pressure. In changing the governor rods, however, there is the possibility of moving the safety cams so far that either the valves will not pick up or the safety cams will not become operative when needed to prevent the engine from overspeeding when the load is removed entirely.

If the valves are properly set with the proper lap and lead and the cutoff is equal on both ends, and it is desired to carry a greater load, all that is necessary is simply to add the load and the governor will assume a lower plane, due to the momentary decrease in speed, thereby causing later cutoff and greater mean effective pressure. This can be carried on up to the point where the piston takes steam about ½ stroke (in a single eccentric engine) beyond which point the valves will not release and the speed will decrease.

To carry any additional load, either the speed or the mean effective pressure must be increased, which can be done by raising the steam pressure or making cutoff later. If cutoff is to be had beyond about half stroke, it is necessary to add a second or exhaust eccentric. Adding a second eccentric will not in itself add more power to the engine, but will make it possible to set the steam eccentric with less angular advance, or in some cases with none at all, making the maximum point of cutoff later and at the same time having late release, late compression and proper lead. This increases the available mean effective pressure and makes it possible to develop more power before the maximum point of cutoff is reached, which may be as late as ⅞ stroke, by simply adding the extra load, and the governor will drop enough to pick it up.

After stating his method in making the change in the governor, which in itself will, I believe, have but little effect on the ability of the engine to carry more load, and may cause misadjustment of the safety cams, Mr. Jones concluded with the statement: "Should the load be thrown off or lightened a great deal, it would cause the engine to run away. It is not advisable to make much of a change unless the operator thoroughly understands the action and probable consequences." For that reason, I believe that it is not out of place to call attention to what might be misunderstood, and to advise against changing the governor rods in an attempt to develop more power, because that will not, in my opinion, increase the available mean effective pressure which under the conditions stated can only be done by adding more load up to the capacity of the engine with a single eccentric, then by adding a second eccentric to give cutoff later than half stroke.

Commenting on the same set of questions, W. S., on page 367 of the same issue, closes his remarks with the statement, "You really cannot obtain cutoff as late as ½ stroke on a single eccentric engine." Theoretically, this is true, as there must be some angle of advance to the eccentric to get the other events at the proper point of the stroke, and the eccentric would pass the center slightly before the piston reached half stroke. In practice, however, it has been proven beyond question with indicator diagrams that a maximum cutoff as late as half stroke or even later has been obtained with a single eccentric Corliss engine running at normal speed, and if I remember rightly the matter was fully discussed some time ago in these columns.

This action may be explained as follows: Assuming that the eccentric is set with an amount of angular advance that, when the engine is turning over slowly the trip cams will release the hook at the latest point, which will be about 7/16 of the stroke, or on a 32-in. stroke at 14 in. Cutoff, however, does not take place until the valve is closed, no matter at what point it starts to close, and during the time that the valve is being closed by the dashpot, the piston which is at its maximum speed at this point would have traveled several inches farther, which might easily bring the latest point of cutoff possible beyond half stroke, and considerably later than it would be with the engine turning over slowly, or, in other words, the time element must be considered.

True, the time required for the dashpot to close the valve is short; but if the engine has a speed of, say, 120 r.p.m., or 2 r.p.s., and it required 1/20 of a second

for the valve to drop, the piston could travel about 6 in. at midstroke while the valve was closing, whereas it would only have to move 2 in. while the valve was closing to reach half stroke, assuming that the trip cams started to release the hook at 7/16, which would be about the limit. This would be augmented by a sluggish dashpot.

Therefore, the statement that cutoff as late as ½ stroke cannot be obtained is not absolutely accurate as applied to a drop cutoff Corliss engine, although from a purely theoretical standpoint it is correct, and in answering this question it might be well briefly to mention this fact to show the examiner that the practical as well as theoretical side of the question is understood. J. C. HAWKINS.

To Improve Diagrams

IN REPLY to the inquiry of J. B., page 402 of the May 1 issue, relative to the required changes in the valve setting of his engine valves, I would suggest that in the case of the high-pressure cylinder the head end exhaust valve be made to open a trifle sooner and that the crank end steam valve be given a little more lead. The expansion line is a little wavy, but that is undoubtedly due to indicator action.

Both ends of the low-pressure cards indicate the necessity of giving the steam valves a little more lead. FRANK WELLS.

THE HIGH-PRESSURE CARDS are pretty good. It may be, however, that an earlier opening of the steam valves would improve matters, although this depends a great deal on the distance the steam must travel in the indicator pipes before reaching the indicator. Compression is a little high in one end; this might be cut down a trifle, consistent with quiet running.

The low-pressure cards show late steam valve opening, unequal compression, unequal cutoff and a very poor expansion line. Judging from the expansion lines, it would appear as if the steam was going past the valves after they are closed and I would therefore try these valves for leakage. TOM JONES.

IN REGARD to the diagrams taken by J. B., as shown in the May 1 issue, I offer the following suggestions:

First, with regard to the diagrams taken from his Allis-Chalmers cross compound engine, I would say that his valve setting and steam distribution are about as good as he can make them. The rounding corners of the diagrams at the steam inlet ends, seem to show that the steam valves open a little bit too late. He might perhaps improve the condition of affairs by giving both the high and low pressure steam valves a little more lead; but aside from that one feature, the diagrams show up very well. They also show that the engine is pretty well loaded, and it would not be economy to place any more load on that particular engine. Of course, more load could be carried by that engine, but not with economy, and if possible it would be well for him to increase the boiler pressure to about 150 or 160 lb., and that will increase the economy of his engine. Of course, he must remember that he can increase his boiler pressure only if it is allowable by law for him to do so. If not, he must endure the pressure he is carrying at present. J. A. WISE.

THE DIAGRAMS submitted by J. B., show plainly that the valve adjustments at the cylinder have been made with great care, yet there appears to exist a late movement of the valves at all points, due to the position of the eccentric on the shaft.

In this case, we will have to consider other conditions than valve setting to remedy the errors. The diagrams were taken by a single indicator located at the center of the cylinder of an engine with a stroke of 48 in. and a piston travel of 792 ft. per min. Under the best of conditions the movement of the indicator piston is momentarily behind the engine piston, and this one particular place is where J. B. will find his apparent late movement. If he will place his indicator on the end of the cylinder and take a diagram, he will find the present valve setting just about correct.

The load is well equalized on both sides of the high and low-pressure piston; but as the scale of the indicator spring was not given, it is impossible to say whether the load was equal on both pistons, although it is only fair to presume that this condition is equally well taken care of. C. E. C.

Cause of Commutator Trouble

IN REGARD to J. C. L.'s trouble with an 8-pole generator, I beg to say that the cause may be: Dirt, low or high commutator bar, unequal brush setting or different resistance of brushes.

If there is one defective point on the commutator it will cause sparking and, if the load is heavy, glowing of the brushes, thus increasing the resistance on that particular point. Suppose it is on brush No. 1, more of the load will be thrown on brushes No. 2, 3 and 4. If this added load is too high, it will heat the brushes to such an extent as to decompose the carbon and start a black or rough spot. The commutator carries some particles with it to the next bar, and so on. With the

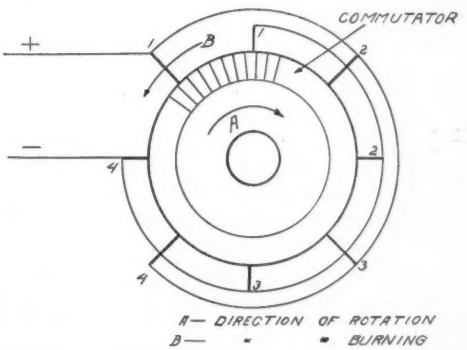


DIAGRAM OF COMMUTATOR SHOWING HOW BARS BECOME BURNED

trouble in the commutator, it will proceed a few bars, provided the commutator is large and the brushes clean it again; but with the trouble in the brushes, it will make the entire commutator surface black and rough and grind in grooves rapidly.

I believe J. C. L. can remedy it only by turning his commutator. In my opinion, poor contact must have been the trouble in his case. FRANK BUDIG.

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Meeting the Issue

Due to the abnormal requirements of the armies of our Allies, shortages of all kinds of commodities have already been experienced with accompanying unprecedented rises in prices, a condition not only certain to continue but to become even more serious by our participation in the struggle against Prussian autocracy. Almost without exception, prices have soared skyward, including those of fuel, oils, supplies and repair parts which have a direct and vital bearing upon the operating costs of steam power plants. And in addition, due to the increasing cost of the very necessities of life, labor costs are higher, thus making more acute a situation already serious.

All these great and revolutionary changes in the life of our nation and the rest of the world are of vital importance and much concern to the power plant man, and though he may have striven hard even in normal times to hold his operating costs at a minimum, it is his duty now to practice still greater economy at all turns and to strive doubly hard to eliminate waste and all unnecessary losses. Primary among such wastes and losses occurring in the boiler room are those which may be traced to carelessness, improperly constructed and defective settings and furnaces, scale- and soot-covered flues and tubes and leaking valves and connections in water and steam pipe lines. But if the losses due to these causes can by a little foresight, care and overhauling of defective equipment be reduced by no more than 20 per cent, the saving effected in the aggregate will be most gratifying.

When mechanical stokers are employed without overhead bunkers and frequently also in the case of hand firing, much fine coal is lost by being scattered about the boiler room and falling between the grate bars, which if reclaimed is capable of developing considerable useful work. Care should also be taken to see that the fuel is thoroughly consumed before leaving the grates, so as to reduce to a minimum the combustible contents of the ash.

Infiltration of air through cracks in the boiler settings is also conducive to low efficiency and should be eliminated as far as possible by repairing the brickwork and going over the entire outside surface with a coat or two of good asphaltum paint.

Many of the greatest economies may, however, be realized by stopping the many leaks which occur in pipe joints and valves, by utilizing the smallest scraps of packing which may appear to be of no further service, by the reclamation and filtration of oil wherever possible and by the installation of machines for the washing of wiping waste and cloths.

Considerable quantities of oil may be reclaimed by equipping exhaust lines with oil separators and by fitting machines which tend to throw oil promiscuously about walls and floors with efficient casings and drip pans.

Boiler water-gage glasses are frequently damaged so as to render them unfit for further use for the purpose intended, but if cut down to the proper size will be found serviceable in connection with separators, lubricators and oil filters.

Where such is not already in existence, the establishment of a stock room, or in the instance of small

plants, some form of locker wherein all supplies and repair parts may be kept, will be found instrumental in the elimination of much unnecessary loss of material. As a further aid in this direction, it is advisable to establish some form of accounting system in connection with such a stock room and make some one man on each shift, preferably the engineer in charge, responsible for all material received and disbursed. In comparatively large plants no supplies or repair parts should be given out without a requisition approved by the chief engineer.

If we may rely upon predictions of authorities, business in general will be stimulated beyond all anticipation. If such is to be the case, many engineers will undoubtedly find their plants lacking in capacity to supply all of the required power, and in addition, due to night shifts which will in many instances be worked, a heavy demand for lighting will have to be met. These abnormal conditions will require the installation of additional machinery and the enlargement of existing plants which with the high price of equipment, material and labor may upon the cessation of hostilities and the return of normal prices prove to be an unprofitable investment; especially after normal conditions are restored and the added equipment may be forced into idleness.

It would appear, therefore, that installation of new equipment except where needed for permanent service, should be delayed until the absolute necessity is evident. And in some cases, used machinery and apparatus may be found to give as satisfactory service as new and at a considerably less outlay.

The labor problem may also require consideration. Inconveniences and serious and prolonged setbacks in any construction work attempted may be experienced due not only to inability to obtain material and machines, but also to shortages of labor and as hostilities progress and more and more of our men may be called to the colors, we as other belligerents have already done, may be compelled to introduce woman labor for some of the lighter work about the plants such as cleaning, switchboard operation and clerical work.

In anticipation of the withdrawal of many plant employes subject to military service by selective draft or universal training, chief engineers may do well at this time to train those of their men not subject to immediate call to fill places which may be made vacant by the enrollment in the federal service of the present workers.

Central Station Rates Rising

Central station rates are beginning to go up as the cost of fuel, labor and supplies increases, and while the advances are moderate in the pioneer cases with which we are familiar, they are none the less real. One company in Massachusetts is increasing its power rates by 1 mill per kilowatt-hour for every dollar's advance in the cost of coal above a $4 base. Another company in the East is seeking authority to raise both lighting and power rates in the thinly populated territory which it occupies, on the ground that the cost of supplies makes an advance of about 15 per cent necessary; and still another company asks permission to put rates possibly 20 per cent higher into effect in a territory recently taken over by an efficient management, a territory, by the way, which formerly was offered poor and unsafe service at lower rates than now appear feasible.

These proposed increases, which may in some cases have to be defended by their authors before the state public service commissions concerned in the regulation of the respective companies, should carry a lesson of encouragement to the operating engineer. Many plants today are heavily handicapped by the high cost of fuel; but it remains to be demonstrated in each particular case which class of service is the more economical from the commercial point of view. The tendency in central station circles is to assume that the present high cost of coal in the isolated plant turns the balance at once in favor of purchased service. In practice, no engineer need be stampeded by this claim, for there is still need of investigating in all its phases the relation of building and industrial heating to power production, before making a decision upon the annual cost, all charge included, between purchased and privately generated power. The fact that central station rates must be taken in hand to meet the rising cost of generation and distribution (for it will not do to forget that a kilowatt-hour delivered at the consumer's meter means a good deal more than that at the station switchboard) indicates the continued wisdom of investigating all power problems with the same care as before in the effort to find the best solution in each individual case.

Great as are the theoretical economies of centralized generation, it is impressive to find that the public utilities supplying electricity are beginning to find it necessary to increase their prices, and while such increases may be temporary, there is no certainty as to how far toward their former levels these prices may go in the future. The central station industry deserves great credit for the wonderful reductions which have been made in the retail price of electricity in the last quarter century, although there is reason to believe that the present maxima might in some large companies, at least, be lowered with increased profit to all concerned; and it is no disgrace in times like these for the smaller central stations, in particular, to have to resort to so-called temporary advances. Snap judgments, however, as to the solution of local power problems, are still very much out of place

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One of the most important natural resources of the country is the supply of clays for refractories, as all industries employing high temperatures are dependent for successful operation upon a good supply of suitable refractory materials. Among these industries are all metallurgical processes, including the manufacture of iron, steel, zinc, copper and brass, and ceramic industries, such as the manufacture of clay wares, insulators, glass and enameled metals. All these industries are essential for a nation engaged in war, so that knowledge of the location, extent and quality of deposits of such materials is of great importance.

In several cases, the refractory materials used in this country are imported, and the war has made them difficult to secure, and greatly increased their cost. There is reason to believe that most, if not all, of these products could be found in this country if a careful geological research were made, so that there is need for pushing such investigation as rapidly as possible. Illinois has been found to contain valuable deposits of high-grade fire clays, especially near Anna, and it is urgent that further exploration be made to determine the extent and character of such researches throughout the country.

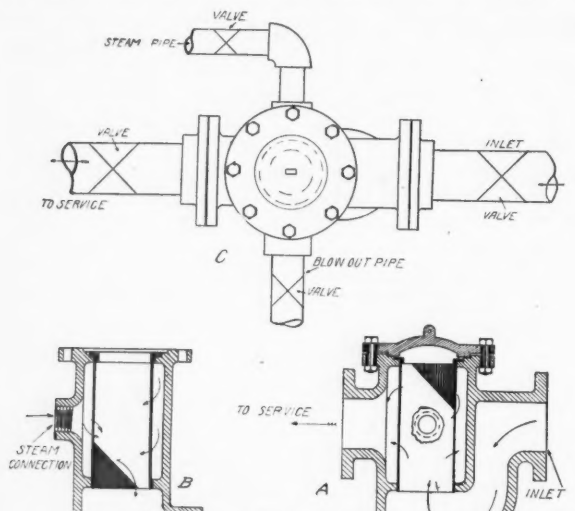
Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Self Cleaning Liquid Strainer

LIQUID entering the inlet passes into the center of the strainer cylinder, through the meshes to the strainer chamber and out to the service line, as shown on view A. The strainer cylinder has open ends, the upper one having a flange which is held, but not clamped between the cover and body of the strainer, and the lower end of the cylinder fits into a guide at the bottom of the chamber, thus allowing for expansion and for easy removal.

To clean the strainer, valves in inlet and outlet pipes are closed, the steam valve opened, admitting steam to the chamber around the cylinder, then the blowoff is opened, and the steam blowing through frees the meshes of all arrested matter, carrying it to the blowoff pipe, as shown on view B. Arrows show the direction of



PLAN AND SECTIONS OF COLLINS SELF-CLEANING STRAINER

flow in service, and when cleaning. A "splitter," not shown in in the cut, diverts the steam from direct impact on the strainer and tends to equalize the pressure in the chamber when blowing off.

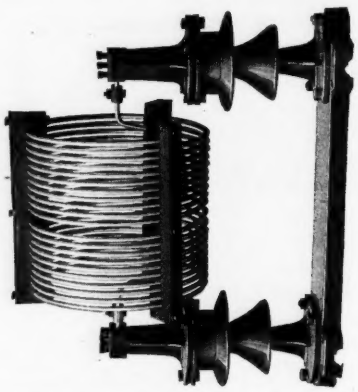
Cleaning may be done without closing outlet and inlet valves, when no liquid is flowing through the strainer. Opening the blowoff and then the steam valve will force the arrested matter out by the path of least resistance, which will be through the blowoff pipe.

This strainer is applicable to all kinds of liquid service from ¼-in. lines to the largest sizes. Four-inch sizes with ¾-in. steam connection have been in use for coal tar service 24 hr. a day for 18 mo. without removing the strainer cylinder, steam cleaning being done once a day in a few minutes. Also in hydraulic service, 4-in. strainers have been in long use, the cleaning being done by a 2-in. connection bypassed to the chamber from the inlet pipe.

This strainer was designed by Geo. W. Collin and is made by the Collin Specialty Co.

Westinghouse 9 and 15-in. Choke Coils

THE Westinghouse Electric & Manufacturing Co. has recently added to its line of 15-in. choke coils a new line of smaller coils 9 in. in diameter. Both sizes are listed for outdoor or indoor mounting up to 130,000 v., with a separate line of 9-in. coils for indoor mounting up to 49,000 v. These coils are of the typical



WESTINGHOUSE BRACED CHOKE COIL

Westinghouse construction and are made up of a helix of aluminum rod in the 200- and 400-amp. capacities and of copper in capacities of 600 amp. and above.

A typical feature of their design is the thorough bracing of each turn of the coils, which gives them all the rigidity necessary to withstand the stresses due to line short circuit. This bracing of the turns makes it unnecessary to reduce the diameter of the center of the coil and thus sacrifice much of the inductance in order to prevent sagging. Another notable feature is the construction of the insulator supports which (except in the case of the 9-in. outdoor coils below 49,000 v.) permits inverting the insulators so that the coils can be mounted either upright or suspended from the ceiling.

In the case of the high-voltage coils where built-up insulator columns are used, the porcelain units are bolted together and it is, therefore, easy to replace broken porcelains or add more units when desired.

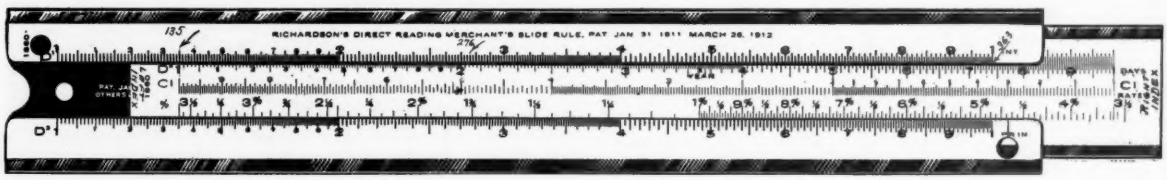
The 9-in. coils, now offered for the first time, have as much inductance as is ordinarily used, and can be

applied in a great many installations where lightning conditions are not abnormally severe and where the apparatus to be protected has good modern insulation. The 15-in. coils have about 5 to 7 times the inductance of the 9-in. coils and afford correspondingly greater protection. They are the largest helical coils now on the market for lightning protection and should be used wherever lightning conditions are very severe or where the apparatus is not new and rugged. For the protection of high-voltage motors and generators connected directly to transmission lines even larger choke coils are vitally necessary.

New Richardson Slide Rules

IN ORDER to comply with the more specialized requirements of the present users of slide rules, and to bring about a greater appreciation of the value of this instrument to those not at present using it, but who could by its adaptation save considerable time and energy, Geo. W. Richardson, T4212 W. 24th Place, Chicago, has recently placed upon the market two new forms of rules known as the Richardson Business Man's Slide Rule, No. 1860, and the Richardson's Pantocrat Logometric Slide Rule, No. 1860-LL, respectively.

As shown in the accompanying illustration, the Richardson Business Man's Slide Rule, two upper scale D^1 and D^2 graduated similarly to the C and D scales of the ordinary slide rule are provided; these may be used for multiplication and division. Below the D^2 scale and occupying the center of the slide is a third or CI scale graduated like the other two but reading in an opposite direction, and is used to obtain the reciprocals of the numbers appearing on the D^2 scale of the slide. There is also a DI scale above the D^1 and a log scale below the D^3 not shown in the cut.



THE RICHARDSON BUSINESS MAN'S SLIDE RULE, NO. 1860

The lower slide scale is labeled "%" at the left and "Rate" at the right; the lower rule scale is designated as the D^3 scale at the left and labeled "Prin" at the right, and is graduated the same as scale D^1 and D^2. These are labeled at the right "Int" and "Days" respectively.

Of particular value is this scale in the calculation of commercial transactions such as involving percentage, taxes, discount, profit and loss, interest, wages, etc., etc.

As an illustration, let us follow the necessary procedure to determine what percentage 6⅜ is of 51.34. To do this, we must divide 6⅜ by 51.34 and multiply the quotient by 100, accomplished by setting 6⅜ on the lower slide scale over the right hand index of the D^3 scale, bringing hair line of runner over 1 of lower slide scale and then shifting slide so as to bring 513 on D^2 scale under hair line. Above left hand index of scale D^2 we find 1242 on D^1. The quotient is 0.1242 and the rate per cent is 0.1242 times 100 or 12.42.

The other or logometric rule is similar to Richardson's Pantocrat (Mannheim) Slide Rule having A, B, C, D, Sin, Log and Tan scales except that the slide has four scales, three of which are folded and are divided to read the log of log in conjunction with the lower D scale.

The value of the logarithm of any number appearing on the D scale may be found by referring to the log scale at the bottom of the rule which scale also indicates the log log of any number on the folded scale of the slide. To find the hyperbolic log of any number on the folded scale, place the hair line of the runner over this number and refer to the value indicated below on the D scale.

This arrangement permits of the rapid solution of any root or power of any quantity (fractional roots and powers included), by direct operation at one setting of the slide, thus making the rule of considerable value in the solution of the formulas involving natural powers or roots or in obtaining the natural or hyperbolic logarithm of a quantity with its characteristic so frequently met with in electric and hydraulic formulas.

When provided with a slide No. 1812 having B and C scales, problems in multiplication, division, the extraction of square roots and cube roots may be solved. Between the B and C scales of the slide is a logarithmic scale by means of which in conjunction with the lower log scale on the rule problems in addition and subtraction may be performed.

Trigonometric problems may also be handled.

Civil Service Examinations

U. S. CIVIL SERVICE COMMISSION announces an examination for electrical engineer. A vacancy in the Springfield Armory, Ordnance Department at Large, Springfield, Mass., at $3000 a year, and future vacancies requiring similar qualifications at the Springfield Armory or elsewhere will be filled from this examination. Duties consist in the preparation of plans for an electric power installation, the inspection and supervision of the installation, and general charge of the electric power and lighting systems. The applicant should have had experience in planning and supervising the installation of electric power plants and be familiar with approved methods of power transmission and lighting. Competitors will be rated on education and experience. Graduation in electrical or mechanical engineering from a college or university of recognized standing, and not less than 2 yr. responsible experience in a position involving the duties or experience described above are prerequisites for consideration for this position. Applicants must not have reached their fiftieth birthday on the date

of making oath to the application. Until further notice and on account of the urgent needs of the service, applications will be received at any time and the papers will be rated immediately upon their receipt. Apply for Form 1312, stating the title of the examination desired.

U. S. Civil Service Commission announces an examination for metallurgist. A vacancy in the Springfield Armory, Ordnance Department at Large, Springfield, Mass., at $3000, and future vacancies requiring similar qualifications, at the Springfield Armory or elsewhere, will be filled from this examination. Duties consist in the superintendence of the acceptance tests of steel and oil, and of the heat treatment of dies and tools. The applicant should have had experience in the chemical analysis and the photomicrographical examination of steel, and in the prescription and supervision of the heat treatment of tools. Competitors will be rated on education and experience. Graduation from a college or university of recognized standing along metallurgical and chemical lines, and at least 2 yr. responsible experience in a position involving the duties or experience described above are prerequisites for consideration. Applicants must not have reached their fiftieth birthday on the date of making oath to the application. Until further notice, applications will be received at any time and the papers will be rated immediately upon their receipt. Apply for Form 1312.

U. S. Civil Service Commission announces an examination, June 5, for radio engineer. Two vacancies, one at Fort Huachuca, Ariz., and one at Fort McIntosh, Tex., Signal Service at Large, War Department, each at $1800 a year, and future vacancies requiring similar qualifications throughout the United States will be filled from this examination. The appointee must be a constructing radio engineer qualified to install high-power permanent radio stations and place the delicate apparatus in successful operation independent of supervision. Competitors will be rated on general and technical education, experience and fitness. Graduation from a 4 yr. high-school course or 4 yr. of study in a school offering a course equivalent to that of a high school, and at least 5 yr. experience with a company manufacturing equipment for wire and wireless telegraphy or installing such equipment for a company or for the Government of the United States, of which not less than 2 yr. were in responsible charge of the installation of high-power radio stations of not less than 10-kw. capacity, are prerequisites for consideration. Applicants must have reached their twenty-fifth but not their fiftieth birthday on the date of the examination. Apply for Form 1312.

U. S. Civil Service Commission announces an examination for expert radio aid. A vacancy in the Department of Steam Engineering, Navy Yard, Washington, D. C., at $6 a day, and future vacancies requiring similar qualifications throughout the United States, will be filled from this examination. Competitors will be rated on technical education, experience and fitness, publications or report. Graduation from a 4-yr. high-school course, or 4 yr. of study in a school offering a course equivalent to that of a high school, and not less than 4 yr. of experience in the manufacture, installation, or adjustment of radio apparatus, 2 yr. of which must have been in a responsible position requiring original design or research work, or direct supervision of radio manufacturing work, are prerequisites for consideration. A course of study including radio work or kindred sciences with the degree of bachelor of science from a school of recognized standing will be accepted in lieu of 2 yr. of experience. The applicant should submit with his application any publication or report prepared by him which will show evidence of his fitness for this position, or in lieu thereof may prepare and submit a technical thesis on some radio subject. Applicants must have reached their twenty-fifth but not their forty-fifth birthday on the date of making oath to the application. Applications will be rated immediately upon receipt and appointments made promptly. Apply for Form 2118.

Book Reviews

Riveted Boiler Joints, by S. F. Jeter; 155 pages, 52 illustrations, 76 diagrams; first edition, New York, 1917. Price, $3.

While primarily this book was intended for those interested in the design and construction of steam boilers such as designers, boiler makers, boiler inspectors, students and engineers qualifying for the position of boiler inspector, much of the material therein applies with equal force to riveted joints for structural work so as to make it valuable also to the structural engineer.

The first chapters are elementary in character, but comprehensive in the discussion of the principles involved in estimating the strength of the usual forms of joints adapted to boiler construction. Subject titles of these chapters are Methods of Joint Failure, Types of Boiler Joints, Efficiencies of Boiler Joints, Boiler-Plate Material, Strap Thicknesses and Rivet Diameters, and Limiting Pitches.

Chapter VIII, entitled Boiler-Joint Diagrams, discusses the use of the 76 diagrams appearing on the following pages by means of which it is possible to determine the efficiency of a joint already constructed or they may be employed as an aid in the design of joints especially when the designer is forced by circumstances to consider a combination of rivet diameters and plate thicknesses out of the ordinary. All of the diagrams given are based on a tensile strength of 55,000 lb. per square inch and a crushing strength of 95,000 lb. per square inch of plate material, and 44,000 and 88,000 lb. per square inch for the shearing strength of rivet material when subjected to single and double shear respectively.

In Chapters X and XI are given complete instructions for making such diagrams so that they may be readily reproduced for other values of plate and rivet strength if desired.

The diagrammatic method of determining joint strength is so simple that there is no object in limiting the range of combinations of plate thicknesses and rivet diameters, and the diagrams in this book include all practical combinations. This method also has the advantage over tables of directly indicating the effect on the strength of the joint, of each proposed change in the design and also permits of the ready indication of the limiting rivet spacing, both minimum and maximum, so that the designer in attempting to attain a high effi-

ciency is automatically warned when he begins to approach a spacing of rivets that will be either too wide to permit proper calking or so close as to produce interference in driving the rivets.

THE DRIVING OF MACHINE TOOLS, by Thos. R. Shaw; 221 pages, 139 illustrations and 37 tables; first edition, London, 1917. Price, 4s. 6d.

This little volume, which is the outcome of a series of lectures on Machine Tools given by the author at the Royal Technical Institute, Salford, England, has been prepared to give those interested in the subject some simple and rational methods of arranging a drive to give the results desired, and to include such formulas, rules and data as required. Primarily it is intended for those having designing to do along this line, both the student and the man of experience.

The work is divided into eight chapters, the first of which is in the form of a general introduction. Chapter II is devoted to a discussion of cone pulleys and gearing, Chapter III to the application of the cone pulley, and Chapter IV to the all-gear drive. The remaining chapters bear the titles of Applications of Motor Drive, Planing Machine Drives, Drives for Various Machines and Miscellany respectively.

Pages 207 to 217, inclusive, are devoted to an appendix containing many useful tables relating to the general subject.

INTERIOR WIRING AND SYSTEMS FOR ELECTRIC LIGHT AND POWER SERVICE, by Arthur L. Cook; 416 pages, 248 illustrations and appendix with 47 tables; first edition; New York, 1917. Price, $2.

As stated by the author in the preface, this book is intended as a guide to modern practice in electric lighting and power applications, and in the design and installation of the wiring for such purposes. While the book has been written particularly for electrical workers wishing to become familiar with good practice in these branches of the electrical industry, the information presented is intended especially for superintendents and operators of electrical installations and for wiremen, who may be called upon to make extensions to or changes in existing installations and who need definite information as to the best method of procedure. It is also adapted for use in schools giving trade courses in electric wiring, to supplement instruction given in the shop.

Chapters one to eight, comprising Part I, offer a very comprehensive discussion of electric lighting systems, taking up in order incandescent lamps, arc lamps, principles of illumination, lighting accessories, fixtures, methods of calculating interior illumination and outdoor lighting.

Part II, which includes the following three chapters, is given over to the discussion of motors for industrial purposes, motor starting devices and controllers and the proper selection of motors for various types of installations and conditions of operation.

Many simple rules are given in Parts I and II for determining the size and arrangement of lighting units and for determining the sizes of motors required for various kinds of services.

Following, in Part III, are descriptions of apparatus and fittings for interior wiring, together with detailed methods of calculating the sizes of circuits to meet various requirements. The examples given in the last chapter illustrate and describe typical lighting and power applications reproduced from actual installations. Throughout the book examples are included to illustrate each step. Calculations are taken up in detail, from the switchboard to the lamps, and the method of planning each part of the circuit is explained. This is carried out completely for each system—2-wire, 3-wire, 2-phase and 3-phase.

Of particular value to the electrical worker are the many diagrams of connections, illustrations of electrical machinery apparatus and fixtures, curves and tables.

Catalog Notes

GENERAL ELECTRIC Bulletin 47,190, superseding Bulletin 4997, describes and illustrates alternating-current switchboard panels, 90 in. high, 1150, 2300 and 3500 v., 25 to 60 cycles, 3-phase 3-wire and single-phase, for general power and lighting service. These panels provide for the control of apparatus and feeders installed in generating stations or in receiving and distributing stations.

A CONCISE DESCRIPTION of how such a crude product as waste won its uphill fight into the camp of really standardized specialty articles is contained in the new book, Producing the Fittest in Waste. It is a pithy but comprehensive comparison of the waste of yesterday with that of today. Many photographs are used to illustrate the intensively scientific methods employed in the refining and making of the mechanic's "handiest" helper.

To quote from the foreword:

"The annual expenditure for wiping waste is a considerable item in the budget of an industrial plant or system; so there is every reason why the man who buys or uses waste should apply to the waste question the same keen, analytical judgment that he brings to bear upon his purchases or operation of mechanical equipment.

"To spread a wider knowledge of Standardized Waste as a highly developed specialty article is the purpose of this book."

Readers of Practical Engineer may have free copies upon application to the publishers, The Royal Mfg. Co., Rahway, N. J.

LOSSES DUE TO leaking blowoff valves are shown in a table compiled by the engineering department of Homestead Valve Mfg. Co., Homestead, Pa., and contained in a circular which also illustrates the Hovalco angle blowoff valve and double blowoff arrangement, and Homestead quarter-turn plug cocks.

A PORTION OF President Wilson's proclamation, which Link-Belt Co. considers of particular interest to manufacturers at the present time, has been printed in colors on hangers which the company will be glad to send anyone addressing its Chicago office, at 39th St. and Stewart Ave.

PENFLEX METAL HOSE is illustrated in a pamphlet lately received. This tubing consists of a continuous length of bronze or galvanized steel tape rolled in a spiral so that the edges interlock, forming a 4-wall

construction; as the tape is rolled a groove is formed, containing asbestos packing. The maker is Pennsylvania Flexible Metallic Tubing Co., of Philadelphia.

ELECTRIC TOOLS Bulletin No. 101 and Flexible Shaft Bulletin No. 102 have just been received from Stow Mfg. Co., Binghamton, N. Y.

SPECIAL BULLETIN of The Merchants' Association of New York discusses the fly as a carrier of disease germs and gives United States Government and other suggestions for its destruction.

THE LATEST FOLDER of Plant Engineering & Equipment Co., Inc., 6 Church St., New York, illustrates and describes the Guaranteed Corliss Valve Steam Trap, which is of constant flow type, for every condensation removal service.

USES OF "National" Pipe, "National" Bulletin No. 27 of National Tube Co., Pittsburgh, Pa., illustrates many uses, together with some description; also, engineering tables giving information about the physical properties of "National" pipe.

LINK-BELT Silent Chain Data Book 125, 1917 edition, contains besides descriptive matter and illustrations, ratio, speed and horsepower tables, data for determining length of chain, wheel rim dimensions, horsepower transmitted by belts, and other convenient data.

Book No. 260 deals with the subject of Link-Belt and sprocket wheels for sawmills.

MANAGER WISE is the title of a collection of advertisements and data on small motors and their uses recently issued by the Westinghouse Electric & Mfg. Co. as an edition of a publication issued by that company under the title "Small Motors." This pamphlet, which is profusely illustrated, brings out the advantages of small alternating-current and direct-current motors, describing the application and construction of each.

IN ORDER TO supply more readily the rapidly increasing demand for SKF bearings on the Pacific coast, the SKF Ball Bearing Co. of California, Inc., has been organized for the sale of these well known self-alining radial and thrust ball bearings.

The main office of this company under the direction of A. M. MacLaren, has been opened in San Francisco at 341 Larkin St., and at this office a large and assorted stock of bearings will be carried. The engineering services of the company will also be available by addressing this office. The company's engineers will be glad to investigate conditions and assist the users of ball bearings, present and prospective, in determining the best means of reducing friction losses and selecting an equipment.

From sketches showing the arrangement with data giving the loads and speeds and other conditions which bear on the problem, the engineers' suggestions based on their wide experience will be found helpful. They will gladly answer questions, make suggestions upon the data submitted, examine and criticize the drawings or make drawings showing the preferred method of applying SKF ball bearings to meet particular conditions. Proper sizes and arrangements will be suggested.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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SEMI-MONTHLY

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Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—By young man 21 yrs. in a power plant of 1000 kw. or more where there is a good chance for advancement. Not particular about wages or kind of work to start with. Have had a year's experience night engineer in 25 kw. plant and one year as head of 200 hp. heating plant. Can furnish best of references. Strictly sober. Am anxious to learn, but patient. Address Box 200, Devil's Lake, N. D.
4-15-3

POSITION WANTED—As chief engineer. Have had 10 years' practical experience. Especially qualified to handle the plant on an efficiency basis, reducing coal consumption and operating costs. Must locate in Chicago. Presently employed, but have good reasons for desiring a change. Address Box 479, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 5-15-2

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—Fireman with first-class Mass. license would like to locate near Boston, Mass. Day work, 8 or 10-hour day. Sober and reliable. Best of references. Address R. C., 17 Cozenore St., Boston, Mass.

POSITION WANTED—By engineer competent to operate Corliss and high speed engines and turbines. Familiar with a.c. and d.c. generators and refrigeration. Age 27. Married. Sober. Desire position around New York. Address A. Kahel, 233 S. 4th St., Brooklyn, N. Y.

POSITION WANTED—By man 30 years old, good habits, married, with 6 years' experience in steam electric plants. Would like position as engineer in plant of 2500 kw. capacity or more, where I can advance myself. Address Box 471, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—Young man, age 28, as engineer in New York or Brooklyn. Hold marine, stationary and refrigeration license. Day work, 8-10 hours, desires to go to school nights. Write for particulars. Box 452, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 5-1-3

POSITION WANTED—As oiler, by young man, age 21, single. Willing to accept position in any city. Address Peter Stanys, 670 W. 18th St., Chicago, Ill. 6-1-1

POSITION WANTED—As fireman or oiler in large plant; 3 years' experience as fireman, 18 months as assistant engineer. Married. Strictly sober. Prefer Southern States. L. C. Drake, Cambridge City, Ind. 5-1-3

POSITION WANTED—as chief engineer in industrial plant, Missouri, Arkansas, Kansas, Iowa or Nebraska, or as Superintendent of light and water plant in city of 2500 to 8000. Ten years' practical experience with steam, electrical and water systems. Technical training. Now employed by U. S. Government as engineer and instructor. Executive ability. Can report on 15 to 30 days' notice. Married. Age 30. Address Practical Engineer, Box 466, 537 S. Dearborn St., Chicago, Ill. 6-1-1

POSITION WANTED—By young man, 23 yrs. old, as fireman or oiler in ice and electric light plant in City of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St. St. Louis, Mo. 4-15-4

POSITION WANTED—As engineer in small power plant. Five years' experience as engineer in grain elevator. Good mechanic. Steady and sober habits. Single. 28 years old. Central states preferred. Box 115, Walcott, Iowa. 5-15-2

POSITION WANTED—By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. 6-1-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

For Sale

FOR SALE—75 Kw. G. E. 125-250 volt 3-wire generator, dir. con. Buckeye side-crank engine, like new, $1,250. Two 40 Kw. G. E. 125 volt belted generators, $300 each; 13x13 Chuse automatic engine, $300. Power Machinery Exchange, Jersey City, N. J.

FOR SALE—Four-inch standard brass drop pipe in 5-20 ft. length, complete with brass guides and rods, all practically new. Owner putting down new well. The Brenneman Baking Co., Columbus, Ohio. 5-15-2

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 H. P. to 250 H. P. The Pittsburg Boiler & Machine Co., Pittsburg, Kansas. tf

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Although many large and important advertisers have advanced the price of their product, it is interesting to know that they have in the majority of cases held off until the very last minute, after suffering a great loss by so doing.

"Printers' Ink," in an article by John Allen Murphy, tells of some of the sacrifices advertisers are willingly making to conserve the good will of their business.

Those who have been following the price course of well known advertised brands of merchandise for the past two or three years could find no better proof of the value to the public of a standardized product. Though the prices of raw materials have been vaulting to altitudes scarcely ever known before, and though the cost of producing manufactured articles has increased tremendously, the prices of a long list of well-advertised products have either not advanced at all, or else the advance has been so small that it is out of all proportion to the increased manufacturing cost. And even when prices were raised, often the move was not undertaken for a long time after it became vitally necessary to charge more for the goods. The manufacturers voluntarily and deliberately shouldered the increased burden as long as it was in their power to stand it.

The last two or three years have convincingly shown that when a manufacturer has standardized his product, both as to quality and price, and through advertising has popularized it, he will suffer every sort of inconvenience, even great financial loss, rather than depart from his standards or disturb the condition that he took such pains to establish.

It is no exaggeration to say that this has been demonstrated in hundreds of cases. In several instances the writer has been taken behind the scenes and has been given an opportunity to see the lengths to which our modern manufacturer is willing to go to protect the buyers of his goods against price advances and lowered quality.

* * * *

That many of our big manufacturers have been able to keep from advancing prices for so long is a victory for the efficient organization, for resourceful management, and above all, for standardization. Look how the Diamond Match Company fought to enable the dealer to continue selling a standard box of matches for five cents. Just see how some of the things used in making matches have gone up. Muriate of potash advanced over 1,200 per cent; chlorate of potash about 1,000 per cent; paraffine wax around 300 per cent; match glue near 500 per cent. Spectacular advances have been shown in nearly all other ingredients. These baffling conditions have not been met for two years and yet it is only a few months ago that the company raised its prices. Progressive research, resource in finding new ingredients or in changing processes enabled the company to hold the price down longer than would have been otherwise possible. Permanent gains in efficiency are likely to result from the valuable discoveries made by many of our manufacturers in their struggle to keep the prices of their products from advancing.

In these days when the finger of public suspicion is pointed to every concern that is obliged to raise a price and where many are suspected of gambling in life's necessities, or of needlessly juggling their prices, it is refreshing to know that many of the big manufacturers of trade-mark products are pitting all the resources of their organizations against price advances. They have standardized both their products and their prices and by advertising have established valuable relations with the public. Naturally they will not permit anything to disturb those conditions, unless it is unavoidable.

Furthermore, it is common talk in some trades that the disposition of advertisers to hold prices down as long as they can has had the effect of checking the general tendency in the trade to advance prices. The National Biscuit Company, for instance, in some quarters was severely criticized for holding back its advance as long as it did. The incidents related in this article and the dozens of others of a similar nature that might be told if space permitted, contribute new evidence in support of every advertising man's contention that advertising decreases the cost of living rather than increases it, as some are so fond of asserting.